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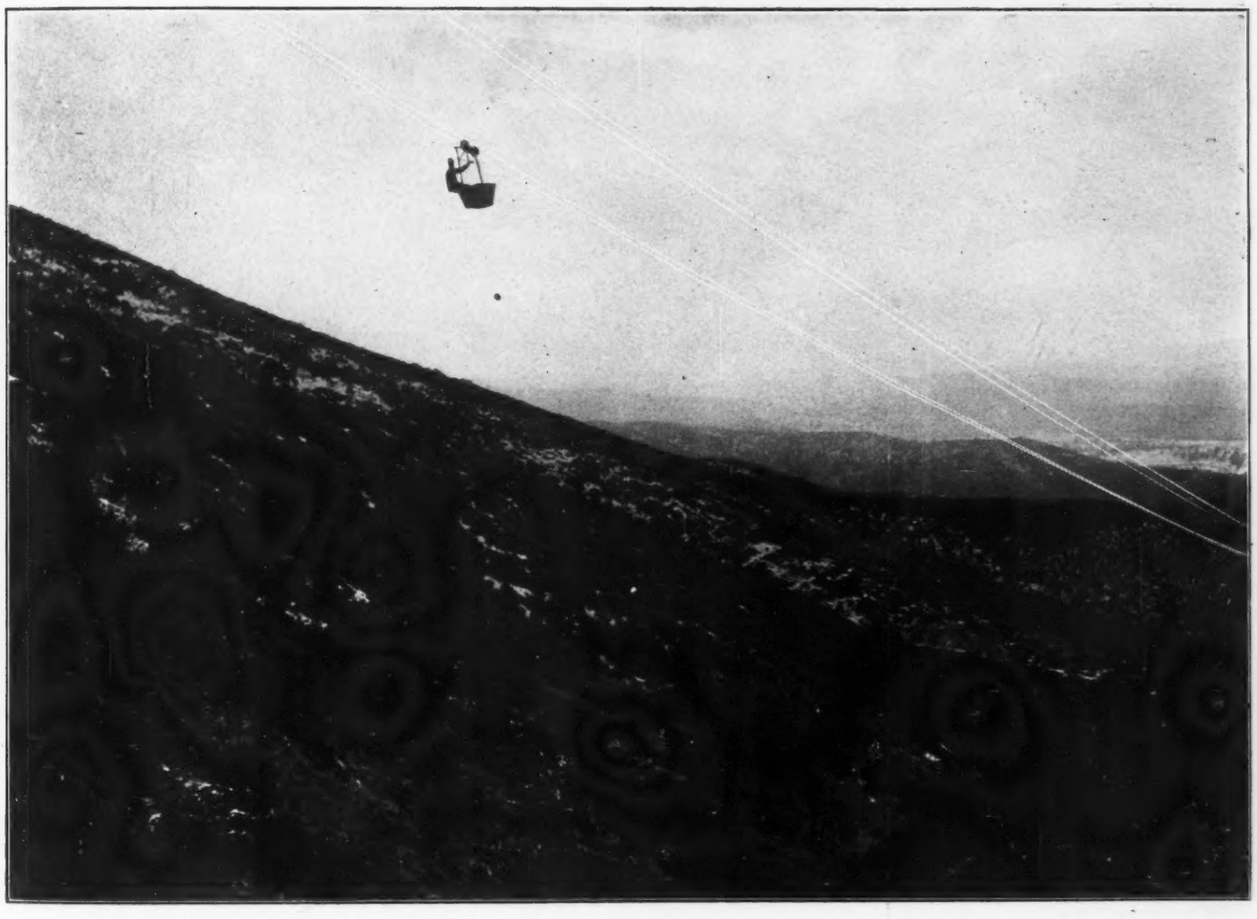
A New Design of Aerial Tramway.

BY GEO. K. DAVOL

THERE has recently been installed at the mines of the American Magnesite Company, in Santa Clara County, a wire rope aerial tramway embodying in its design several radical departures from ordinary practice.

The tramway has proved very successful, and as several of its characteristic features have shown themselves to be distinct advances in tramway building, it may warrant a somewhat detailed description.



AT THE CENTER OF A SPAN

The Magnesite mines owned by the American Magnesite Company are located in the northeastern corner of Santa Clara County, some thirty miles south from Livermore, and at an elevation but little less than that of the summit of Mount Hamilton, from which they are distant about fifteen milesin a straight line.

Magnesite, composed principally of carbonate of magnesia, is one of the most refractory substances known. It is found in very few localities in the entire world, and in no place in this country outside of California. The large American demand for magnesite and magnesite bricks, due chiefly to the steel industry, and for many magnesia compounds, has up to this time been supplied from the mines in Greece, and the opening of these California mines, with their almost unlimited deposits, within eighty miles of San Francisco, is expected to have a very marked effect on many important industries.

The coincidence may warrant the remark, that this rather barren and apparently worthless corner of Santa Clara County embraces within a radius of a few miles large deposits of two minerals, magnesite and mercury

both of which are found at very few points on the earth's surface.

This portion of the country is very rough, mountainous and naturally inaccessable, and the question of the transportation of the magnesite to Livermore, or other point of outlet, has been a matter involving much consideration at the hands of the officials of the magnesite company.

The question, however, solved itself for a time at least, through the formation by outside capital of a corporation which contracted to haul the output of the mines by means of steam traction engines from the camp at Red Mountain to Livermore, a distance of thirty-two miles.

A road was built connecting these points, partly by the County of Alameda, through which it passes, and partly by the magnesite company. This road, completed last September, is a splendid piece of work, and in places, in strong contrast with the ordinary American mountain road, suggests methods of road building in vogue in Europe; winding as it does up canons and through the mountains, climbing the 2500 feet up to the camp at Red Mountain with a practically uniform grade which never exceeds 5 per cent., and with never less than fourteen feet of clear roadbed.

The ultimate capacity of the steam traction engines over this road is something still to be determined, as at the date of writing the regular haulage over the road has not been established.

The camp at Red Mountain lies at the foot of a half circle of hills on the sides of which the white croppings of the magnesite appear, and in which the enormous veins of the solid mineral lie; veins of clear magnesite; pure, and dazzlingly white, in which tunnels have been driven crosswise, sixty feet in length without passing through.

THE MAGNESITE MINE AND UPPER TERMINAL OF TRAMWAY

These tunnels when newly opened through the solid magnesite present a very beautiful sight, for throughout their length, after entering the vein, no break or blemish is encountered to mar the absolute even purity of the mineral, which glistens beautifully white by the light of the candles.

There remained the problem of taking the ore from these mines to the camp below, a distance running somewhat less than a mile, and embracing differences in elevation averaging some 700 feet.

For this link in the chain of transportation an aerial tramway was decided upon, and the tramway which was finally installed has a length of a little over half a mile and a fall between loading and delivery terminals of 650 feet.

This tramway is, therefore, not remarkable for length, nor is it so for its designed capacity of twenty tons per hour. The interest lies in a number of departures from the prevailing mechanical design of aerial tramways, which have the effect of making it simpler, safer and more reliable in operation.

This tramway is of the double rope type, having stationary track ropes on which the carriers are hauled by an endless hauling rope to which they are attached at intervals. The track ropes are anchored at each terminal, while the hauling rope takes a half turn around a ten foot sheave which is mounted on a vertical shaft at each terminal.

LOADED AND EMPTY CARRIERS PASSING TOWERS

Aerial tramways of this general type have undergone in the past ten years a great amount of alteration and improvement in their general design, and we will briefly outline the steps which have marked this development and led to the adoption of the features found in the tramway here described.

In the original tramways of this type, the carriers were secured to the hauling rope by means of grips, which were operated by hand at each terminal, permitting, as was originally deemed necessary, the stoppage of the carriers at each terminal for loading or discharge, and which as originally carried out, involved the operations of opening the grip, switching the carrier off the line and pushing it around the terminal and on to the return line, accelerating the carrier to the proper speed, and then closing the grip on the hauling rope, all of which had to be done by hand, and in addition to the operations of loading and dumping.

The terminal structures of these original tramways were large and expensive, carrying as they neccessarily did long lengths of transfer track on which the carriers were loaded and dumped and transfered around the terminal by hand.

It generally happens that the terminal structures of an aerial tramway, particularly the delivery terminal, have to be elevated at a considerable distance above the ground, and therefore when the terminals are long, the cost of the necessary sub-structure on which they are elevated and which have to take the pull of the ropes, rapidly becomes excessive.

The labor charges on these tramways of old design was also heavy, as at least two men were required to be actively engaged at each terminal, or at any transfer station. In the lavish use of manual labor which the

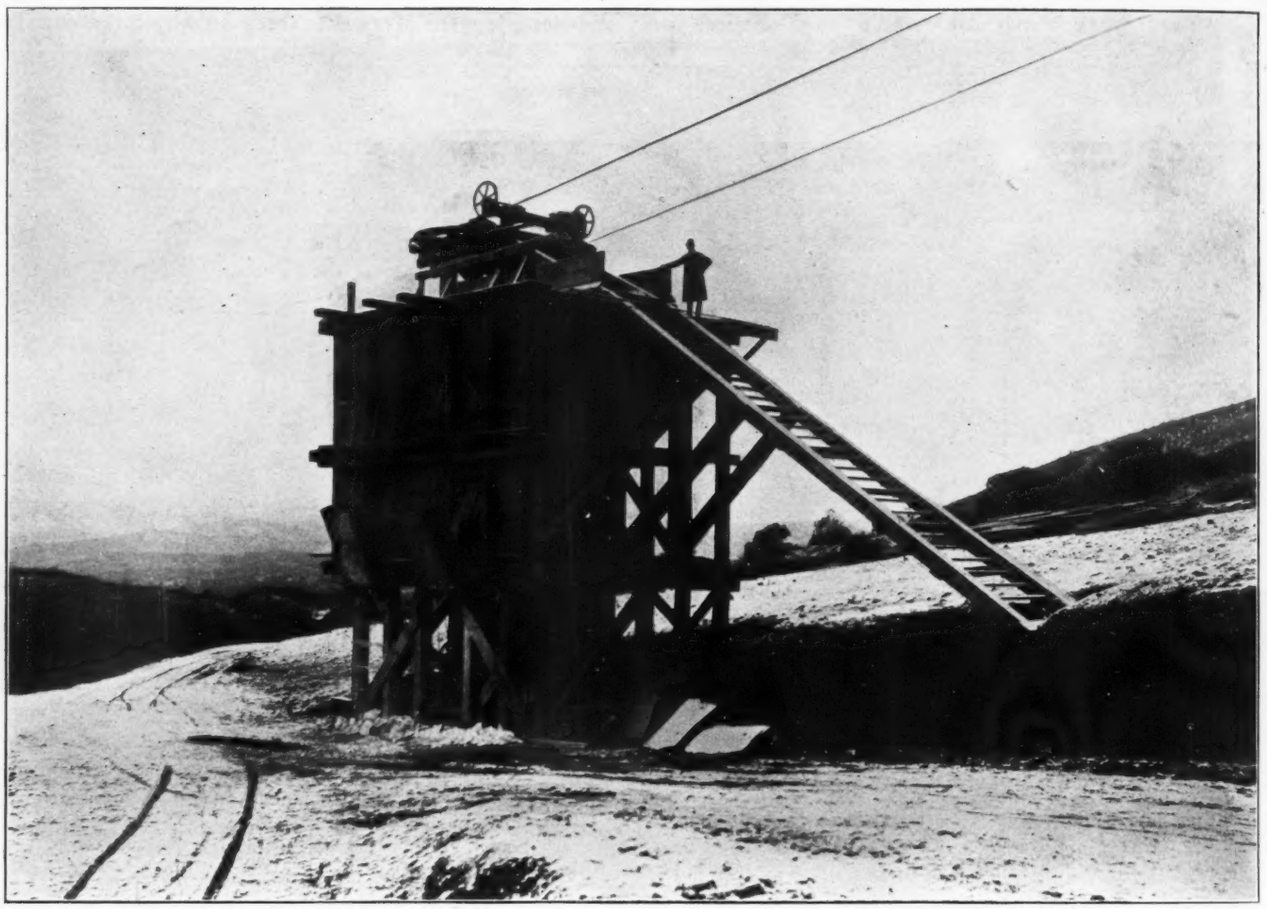
operation of these old tramways required, may be seen the characteristics of German design, to which must be attributed the needless and expensive refinement of many features of detail, but to which also must be given the credit for the original development of the double rope aerial tramway.

One of the most important steps in the improvement of the original designs consisted in providing for the automatic transfer of the carriers around the terminal sheaves and on to the return line, which was accomplished by so constructing the grips that they would pass around the sheave, and in providing a semi-circular track close to the rim of the terminal sheaves.

Automatic grips were then introduced which were automatically operated by various ingenious mechanisms at either terminal, and machinery was provided by which the carriers were accelerated to the required speed before the grips were closed. Apparatus was then introduced for automatically dumping the carriers.

Devices of this nature rendered tramways of this design nominally automatic, and capable of being operated by the active services of but one man, but the amount of machinery and complication frequently introduced entailed the necessity of other employees to oversee the operation of the "automatic" devices.

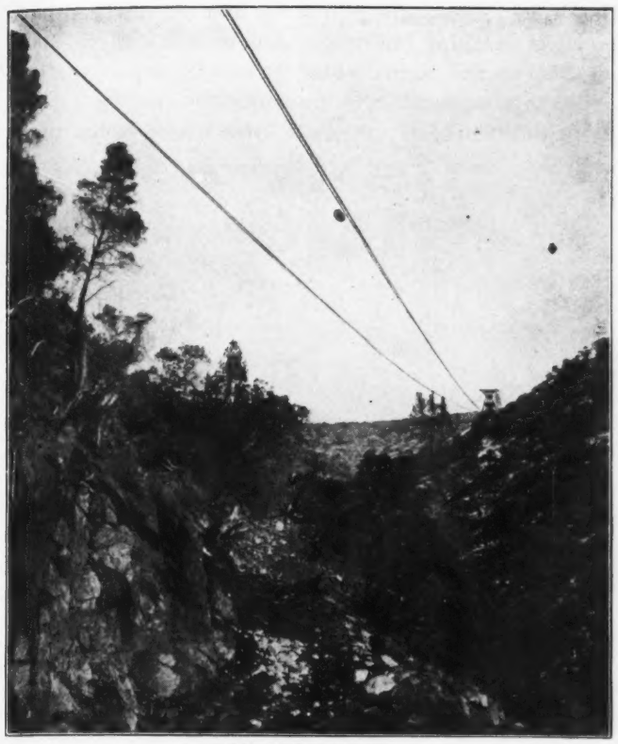
Grips of every description, friction grips or grips made to engage with lugs or buttons attached to the hauling rope, proved exceedingly troublesome, and were always a source of wear on the hauling rope, uncertainty in action, and actual danger. It was therefore a distinct advance when the experience of one manufacturer led him to discard the grip altogether and *permanently attach* the carriers to the hauling rope by a suitable substantial clamp, and to provide means for loading the carriers while in motion. The dumping of the carriers at any point was naturally easily accomplished by hanging the buckets so that they normally remained inverted, which rendered them self-dumping on being released from the catch which held them upright.



THE LOWER TERMINAL

It can be said that few advances in tramway design have been so conducive to simplicity and reliability as the apparently simple step of permanently attaching the carriers to the hauling rope, and keeping them to constant motion.

This permanent attachment of the carriers to the hauling rope necessitated the introduction of the automatic loader to load the carriers while in motion, but this apparatus in its latest forms, has proven itself satisfactory and practically free from uncertainty in action. The automatic loader is moreover constantly under the eye



ACROSS THE CANYON

of the one operator required to handle a modern tramway, and any clogging of excessively large pieces of ore can be readily relieved.

The automatic loader consists of a car having a hopper which when at rest is loaded from the ore bin chute by the attendant. This car is arranged to travel a short distance along side of, and close to the moving carriers, as they in turn pass through the loading station, and during this short travel the hopper is emptied into the bucket of the carrier. This travel of the car and its return to the ore bin chute is automatically accomplished by suitable devices which accelerate the car slowly and uniformally and enable large loads to be handled with ease and certainty.

Other incidental advantages of the permanent attachment of the carriers to the hauling rope are that the carriers are always evenly and properly spaced, which often has a very important effect on the running of the tramway, and also, the carriers being evenly spaced, if an even number of carriers be used, two carriers are passing around the opposite terminals at the same time, which is a convenience to the operator.

Equalling in importance the permanent attachment of the carriers to the hauling rope, is the manner of attachment, or rather, the point at which the hauling rope is attached to the carrier, and the way in which the hauling rope is supported. It is in these particulars that the tramway forming the basis of this article differs from others of modern design, and to these points we will devote some explaination.

In Figure 1 is shown an end view of a carrier passing a tower and a side view of a carrier approaching a tower on an incline. As here shown the hauling rope is attached to the hanger of the carrier at a point at some distance below the point of suspension from the trolley. It will also be seen that the drum placed upon the tower for the support of the hauling rope is some distance below the bucket of the carrier, so that when

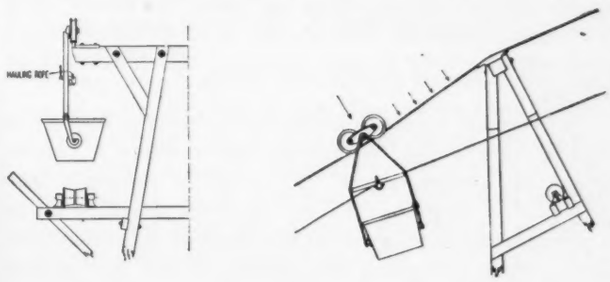


FIGURE 1

a carrier approaches and passes a tower, the hauling rope is lifted off its supporting drum and its weight taken by the carriers itself.

If the tower be located between spans of moderately long length, the weight of the rope thus thrown on the carrier, amounting to say three-quarters of a pound per foot length of span, is considerable in itself. When, however, the towers are located on hill tops or at points where a vertical bend is made, then the downward component of the tension in the rope becomes very great, and the downward pull thrown on the carrier when passing such points becomes enormous, and not only necessitates very heavy construction of carriers themselves, and the hauling rope attachments, but as the downward stress ultimately comes on the track ropes,

AT THE BREAKOVER, SHOWING EVEN DEFLECTION OF CABLES

excessive wear of the track ropes at such points ensues.

This wearing of the track ropes at the towers is noticeable at all towers on lines built on this system, but at towers where hill tops are rounded it is of course much greater and frequently necessitates rails being laid above the ropes at such points, or an excessive number of towers being employed, or as has been frequently done in tramways built on this system, a continuous trestle equipped with rails is built covering the breakover or hill top.

To overcome this action and the necessity of lifting the hauling rope off the supporting sheaves when a carrier passes, the general type illustrated in Figure 2 was evolved. In systems of this type the hauling rope is permanently supported at the towers by sheaves placed upon a cross arm above the bucket of the carrier, the position of the sheave being carefully adjusted so that a slight movement of the grip or other attachment permits the rope always to rest on the sheave.

This arrangement shows a great improvement over the first, as no stress due to the weight or tension of the hauling rope is thrown on the carrier.

It will be seen, however, that in this arrangement the

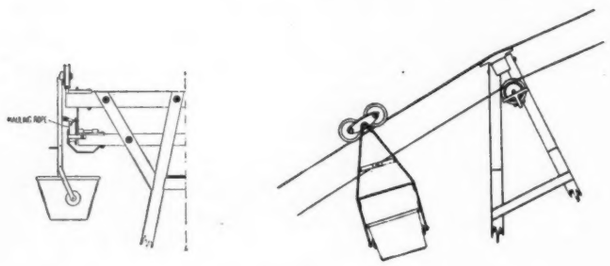


FIGURE 2

carrier must pass the tower in a perfectly plumb or vertical position, otherwise it would either throw the rope off the supporting sheave or collide with the sheave or cross arm. The action of the rope is, of course, to straighten the carrier as it approaches a tower, but if from any cause, such as a violent or gusty wind, the carrier be oscillated, there is danger of the rope being thrown off, with a resulting strong chance of accident, as the carriers are then liable to strike the sheave or cross arm with disasterous results.

It will be seen in both these systems that on an incline the carriers are tilted by the pull of the hauling rope. This is not a matter of serious import, but it is nevertheless objectionable, as it always in conjunction with the natural vibration of the carriers in passing the towers causes a shifting of the load in the buckets which is more or less pronounced according to the steepness of the inclines.

In Figure 3 we illustrate by diagram the system introduced to obviate the troubles to which attention has just been called, and on which the tramway herein described is built. As can be seen from these and other illustrations, the hauling rope is attached to the carriers at the point from which the hanger is suspended from the trolley, so that the pull of the hauling rope can have no effect in tilting the hanger and bucket and can have no effect on the carrier whatever save to impart motion.

By this arrangement, moreover, the hauling rope is carried over the top arm of the towers, and inside of or

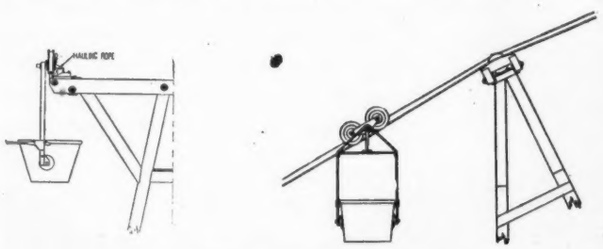


FIGURE 3. IMPROVED SYSTEM

between the two track ropes, so that it is a practical impossibility for the rope ever to get off the towers, the track ropes forming guards which absolutely eliminate all chance of it ever being displaced.

The carriers when passing the towers are perfectly free to swing in any direction, as the swinging of the bucket of the carrier out or in with reference to the tower, only acts to move the hauling rope a little from the center of its supporting sheave; but the maximum swing which the clearance at the tower will permit still allows the hauling rope to rest on its sheave. This end is attained by making the hauling rope clip by which the carrier is secured to the rope, with a loose or universally flexible connection to the carrier, and by putting the supporting sheave close to the point from which the carrier swings. This freedom of swinging can be readily appreciated from the drawings shown in Figure 4 which shows the trolley of the carrier in two extreme positions of oscillation.

The construction of the towers permitted by this arrangement give, as can be readily seen from the views, large clearance for the bucket; all supplementary cross arms for the support of the sheaves being done away with.

The sheaves used for the support of the hauling rope are mounted on revolving shafts which turn in bronze

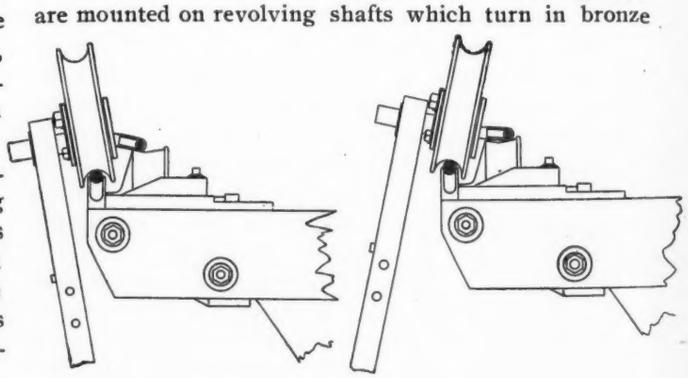


FIGURE 4

bushed bearings provided with means for continuous lubrication.

In Figure 5 is shown a section taken through the center of a supporting sheave and the track rope saddle casting on which it rests.

A 30-FOOT TOWER

The sheave is cast with a chilled tread and is cast on the shaft. It is supported in bronze bushed bearings and passes through a large oil box which is filled with oil and waste and which maintains a continuous and efficient lubrication for months without attention.

The oil box casting is seperate from the saddle casting in which it rests, being held in place in a recess simply by gravity and the pressure of the rope, so that it can be readily lifted off and replaced whenever desired.

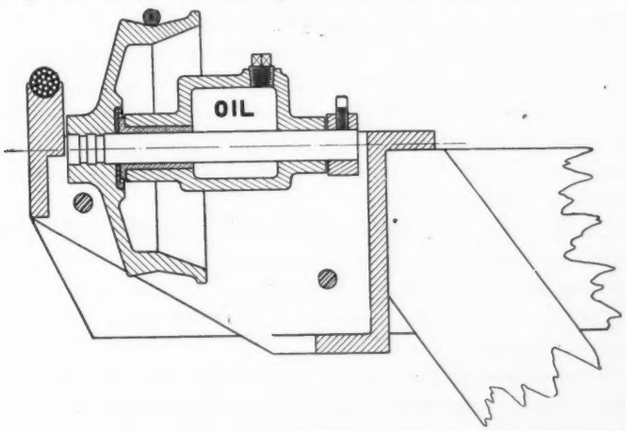


FIGURE 5

The relative positions of the saddle and sheave can never change and never need adjustment, all screwed or bolted fastenings are eliminated, ample bearing surfaces are provided and continuous lubrication insured, so that the inspection demanded by the tower machinery which has in many tramways proved troublesome and expensive, is greatly reduced.

It is worthy of remark that all bolted or screwed fastenings on either the carriers or tower machinery are carefully eliminated as far as posssble, and when absolutely demanded means are provided for positively locking the nuts with bent steel keepers. The importance of these precautions can hardly be exaggerated.

An important and novel feature of this tramway lies in the fact that the hauling rope is not spliced to make an endless rope, as has been heretofore invariably done in all double rope tramways, but the two ends are brought together at one of the carriers and there connected by means of a large and extreamly powerful clamp which is properly supported by a special rigging on the carrier.

This arrangement permits any stretch in the hauling rope being taken up at any time without resplicing, and with very little trouble, and cuts out all tension rigging which it has been customary to provide for the hauling rope at the lower terminal. This tension rigging for the hauling rope is commonly provided for by mounting one terminal sheave on a movable frame which is pulled back by a suitable weight. As the carriers must pass around this sheave, the semi-circular transfer rail must move with it, and as rail connections must be made with this movable rail section, telescoping rails are introduced; all of which has rendered the terminals heretofore very complicated and requiring considerable space.

The necessity of a tension rigging as commonly used, is not due to any demand for an absolutely uniform tension in the hauling rope, but is due to the fact that to take up stretch in the rope by resplicing, from twenty to forty feet have to be taken up at once, and therefore the tension rig is provided to take up any lesser amount.

APPROACHING A HILLSIDE TOWER

The effect of doing away with such tension apparatus is very apparent from the illustration of the lower terminal, which in its compactness and simplicity contrasts strongly with the extensive structures and complication which the ordinary tension apparatus at the lower terminal entails.

In addition to the hauling rope tension apparatus, it was formerly customary to attempt to maintain a uniform tension to the track ropes by means of tension weights properly attached to the ends of the ropes. The action of these weights, if carefully and properly applied, would be to maintain a uniform tension in the ropes independent of changes in temperature and loading. As they have been frequently applied, however, they are absolutely inoperative and without effect. This has been chiefly due to the excessive friction of the ropes on the saddles, particularly at the terminals, where in consequence of bad design they have been frequently deflected at considerable angles over the terminal saddles before being attached to the tension weights. With even very low coefficients of friction, it is readily seen how a small angle of deflection over a stationary saddle will nullify the action of a weight in maintaining an even tension, and when it is not only one angle but a number of angles over a series of towers the equalizing action of the weight is still further counteracted.

It is, of course, possible by providing tension weights at frequent intervals, involving the use of tension stations, and exercising great precautions to prevent the deflection of the track ropes themselves at the stations, using small ropes and sheaves to take the necessary angles, to provide for an operative tension equalizing apparatus. However, from experience gained with inoperative tension rigs, it has been recognized that such tension equalizing devices were unnecessary, and that the natural elasticity of the rope, together with the variation of the amount of sag in long spans, compensates for any reasonable temperature variations with but very little fluctuation in the tensile stress put upon the rope.

The amount of this fluctuation in tensile stress due to temperature changes can be determined very readily analytically; the length of span and the modulus of elasticity of the rope being two factors, but as the latter probably varies materially with different constructions of rope, and as data covering this point is megre, it is difficult to arrive at any comprehensive formulae for its determination. Individual cases can, however, be readily handled, and its extent will be found to be surprisingly small in any ordinary case.

The track ropes are therefore securely and rigidly anchored at each terminal, being let into large cast iron sockets which are secured to the anchorage by means of small flexible ropes. At the lower terminal the ropes are anchored to the ore bin, which is balasted with rock, and a long bolt and nut is provided for taking up any stretch in the ropes.

The track ropes used are made of large crucible steel wires laid up in a single strand. This forms a rather inflexible rope, but one possessing an excellent wearing surface, and being "solid" metal without a hemp core it is very strong. The track rope on the "loaded side" on which the loaded carriers decend is one and one-quarter inch in diameter, while the rope on the opposite side on which the empty carriers return is seven-eighths inch in diameter. The hauling rope is a five-eighths inch crucible steel six strand hemp center rope.

The carriers are equipped with buckets of 1000 pounds capacity, holding ten cubic feet. This size is larger than formerly used in tramways of similar total capacity, but the use of larger carriers has been found to be attended with many advantages; the carriers weighing less in proportion to their capacity, the wear on the track ropes being less per unit of load transported, the reduction of the number of carriers simplifying inspection, the carriers running at longer time intervals, and the larger carriers being better adopted to the conveyance of miscellaneous "return freight."

In the tramway herein described all miscellaneous material of every description is conveyed up to the mines by the tramway by the power developed by the decending loads. The conveyance of water to the mines from the camp, on which the mines are dependent for their supply, forms a rather important function of the tramway.

From the forgoing description the operation of the tramway is of course well understood, but its action may be summarized as follows: The loaded carriers on arriving at the lower terminal are dumped by striking a trip which releases the catch holding them upright. This dumping can be done either before or after rounding the terminal sheave. After dumping, the bucket remains inverted and proceeds up the line to the loading terminal. Thus the empty buckets are always inverted and so offer no opportunity for the accumulation of snow and ice within them while going up to the line, or while remaining on the line over night, which feature in certain districts is very important.

At the upper terminal the buckets are righted as they enter the terminal by an automatic device and are loaded by the automatic loader after rounding the terminal sheave. They then pass on with their load to the lower terminal.

But one man is required to operate the line and he is stationed at the brakes at the upper terminal, as can be seen in the view shown. The duties of this man consist in regulating the speed of the tramway by the brakes and in loading the hopper of the loader from the ore bin chute, for which he has ample time between the passing of the carriers.

This tramway as installed at the magnesite mines has proven remarkably successful, having operated from the start without a hitch and having delivered when called upon to do so much more than its designed capacity.

Its safety in many ways has been repeatedly proven, the buckets on many occasions having been purposely violently oscillated through a wide angle of swing as

they passed the towers with no bad effect whatever, the hauling rope remaining in place on its sheaves.

The hauling rope has been purposely thrown off its supporting sheaves at the towers, and the unfailing action of the next carrier passing in replacing it again has been repeatedly observed.

The buckets are always loaded heaping full and no ore is spilled, due to the constant vertical position of the carriers.

The extreme compactness of the tower terminal, devoid as it is of all tension apparatus for either hauling or track ropes, permits of its being set on top of the comparatively small ore bin used. The saving in heavy sub-structure which would have been required by a terminal of ordinary design has been very material.

The mining of the magnesite is very economically carried out. It is quarried out in the large "glory hole," the opening of which can be seen in the view of the upper terminal, and thrown down through a large storage chute to the lower tunnel, through which it is drawn off in cars to the loading bin at the tramway terminal; so that not a pound of it is lifted from the time it is dislodged from the vein untill it is stored in the bin at the lower terminal of the tramway.

From the lower terminal of the tramway the further transportation of the magnesite is provided for as before stated by means other than an aerial tramway.

General Manager Stillwell, of the Magnesite Company, says: "Had we realized that an aerial tramway could be built which would prove as reliable as the one we have installed, we would have considered a tramway over the mountains about five miles in length cutting out the steepest grades and the hardest hauling between the mines and Livermore."

The tramway was furnished and installed by the Vulcan Iron Works of San Francisco, for whom it was specially designed by the writer.

ALTERNATING CURRENT LABORATORY TESTING.

BY GEORGE H. ROWE.

PART III—CONCLUDED.

INDUCTION MOTORS—EXCITING CURRENT.

As in the static transformer, the exciting current of an induction motor consists of two components, one in phase with the electromotive force or the energy component, and the other the magnetizing or wattless component.

The former is the ratio of the core loss, plus friction, to the impressed volts and the latter is given by the equation,

$$be = \frac{R\sqrt{2}}{P_0 \times N_0}$$

Where b is susceptance, e the impressed volts, R the reluctance of the magnetic circuit per pole, P_0 is the number of phases and N_0 the number of turns per pole per phase.

An example of the calculation of this current is given in the following table:

Density	Length	Amperes Turns
Primary Core....19,150 lines per square inch	4.5	22.9
Primary teeth....20,250 lines per square inch	1.25	16.62
Secondary core...20,700 lines per square inch	3.6	19.1
Secondary teeth..27,450 lines per square inch	.45	2.5
Gap.....15,400 lines per square inch	.045	209
		258.1

This motor had twelve turns per pole per phase

$$\frac{N_0 = 12}{P_0 = 3}$$

Hence

$$be = \frac{258\sqrt{2}}{3 \times 12} = 11.1 \text{ amperes.}$$

The core loss for the same motor was 655 watts or 222 watts per phase. The voltage was 440 and the motor was star connected. The core loss component per phase was $\frac{222}{254} = .835$ amperes.

From the above example, it will be seen that the air gap of an induction motor causes a large wattless current and low power factor as in the open magnetic circuit transformer. It will also be noticed that the magnetizing current varies directly with the magnetic density, and approximately with the air gap, inversely

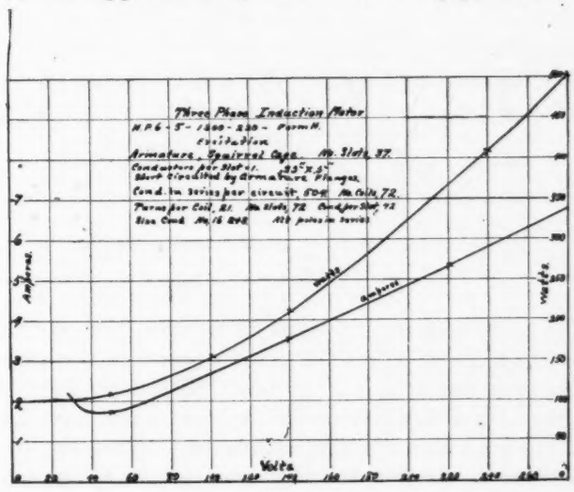


FIGURE 78

with the number of turns per phase per pole and inversely with the number of phases.

Hence the air gap of an induction motor must be small for high power factor. The energy component of the current varies with the core loss and the friction.

Connect wattmeters, voltmeters and ammeters into motor circuit and apply normal electormotive force, allowing the motor to run unloaded at nearly synchronous speed, and observe the instrument readings. Reduce the voltage by steps to zero and plot the results as in Figure 78.

Record the percentage of the exciting current to the full load current. This percentage will vary from 25

per cent. to 50 per cent. depending on the size and design of the motor. Measure and record also the maximum, minimum and average air gap of the motor with belt under normal tension.

FRICTION.

The energy component of the current includes not only the core loss component, but an energy component necessary to overcome friction. By reducing the impressed voltage, the density becomes small, the core loss negligible, and the power supplied to the motor at a given speed is practically the friction reading. The watts curve in Figure 78 is almost a straight line for low excitation, due to the fact that friction is then the chief consumer of power. Produce the curve horizontally until it cuts the axis of y. The power then represented, is very approximately the friction.

IMPEDANCE.

By impedance is meant the stationary impedance of the motor.

It includes the resistance and reactance of both stator and rotor. Block the rotor and pass current of the proper frequency through the motor field up to full load current, observing the pressures required. The ratio of

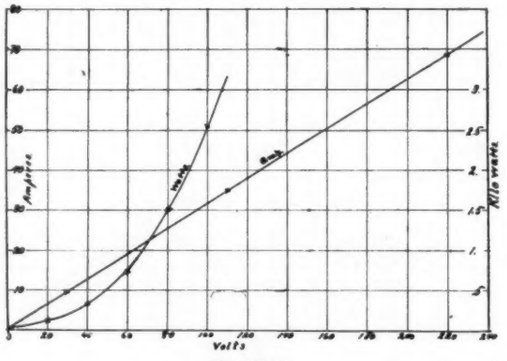


FIGURE 79

volts to amperes will give the impedance. A voltmeter may be included in the circuit as a check on the copper loss, since the iron loss is small with low impressed volts. If the motor is of the squirrel cage type, there will be but one stationary impedance. When the rotor contains a variable starting resistance, the impedance should be taken both with it in series and with it short circuited. Plot curves as in Figure 79.

STARTING TORQUE.

The starting torque of an induction motor is

$$T_0 = \frac{q\ p_1\ E^2 r_1}{4\ \pi\ N Z^2}$$, where p is the number of phases, q the number of poles, r the effective resistance of the rotor circuit reduced to the primary, and Z the total impedance. E is the electromotive force per phase.

The torque can be conveniently stated as:

Torque in pounds at one foot radius=

$$.0588 \frac{\text{No poles} \times \text{No phases} \times (\text{volts per phase})^2 \times (\text{effective resistance})^2}{\text{Cycles} \times (\text{total impedance})^2}$$

The starting torque therefore varies directly with the number of poles, the number of phases, the volts per phase, and as the effective resistance of the secondary circuit; inversely as the frequency and the square of the impedance. The condition for maximum torque at starting is given when the rotor resistance r_1 in series with the resistance r_0 of the rotor winding is

$r_1 = \sqrt{r_0^2 + (x_1 \ x_0)^2}$ (See Steinmetz page 252)

Place a brake on the pulley of the motor. Apply an electromotive force to the field of the motor and balance the turning moment by means of weights. Proper correction should be made for the friction in the bearings of the motor, which tend to act with the weights. The weight of the brake arm must also be balanced or allowed for.

It may not be possible in certain designs of squirrel cage motors or in motors containing little resistance in the rotor circuit, to apply safely full voltage with the armature blocked. In such cases it will suffice to reduce the applied voltage and finally to correct the torque to normal voltage in the ratio (normal volts)^2 (applied volts)^2

Volts (constant)	Amperes 1 2 3	Torque at —— inches	Torque at one foot radius	Torque at one foot radius at normal volts	Position
					1 2 3 4 5 6 7 8

The stationary torque will vary with the position of the rotor with respect to the field. In some motors a dead point may be found. To avoid this the rotor slots are usually an odd number and incommensurate with the stator slots. In small motors, also, the conductors are sometimes "spiraled," especially in fan motors to avoid "dead points." The starting torque should therefore be observed for several different positions of rotor slot to stator slot.

Take a second set of readings with the starting resistance in, if there is one, and plot as in Figure 80.

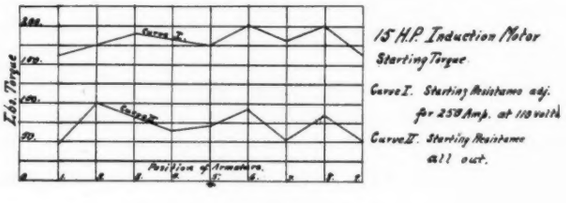

Lbs. Torque
Position of Armature
15 H.P. Induction Motor
Starting Torque
Curve I. Starting Resistance adj. for 250 Amp. at 110 volts
Curve II. Starting Resistance all out.

FIGURE 80

LOAD AND EFFICIENCY TESTS.

Load and efficiency tests may be accurately taken by the brake method. This is usually most satisfactory for accurate results. The "stray power" method using a rated generator is sometimes convenient and may be made to yield accurate results. In this method the motor is belted to a direct current generator and its load is varied by means of a motor rheostat placed in the

armature circuit, the generator field being kept constant and separately excited. To obtain the total load on the motor then, we must add to the output of the generator the following losses of the latter.

The C^2R of the armature, core loss, bearing friction due to the weight of the armature, and also due to the tension of the belt. The variation in speed from no load to break down is usually about from 10 to 20 per cent. At the conclusion of the test, the leads of the induction motor are disconnected from the mains and it is then driven by the direct current machine, which is run

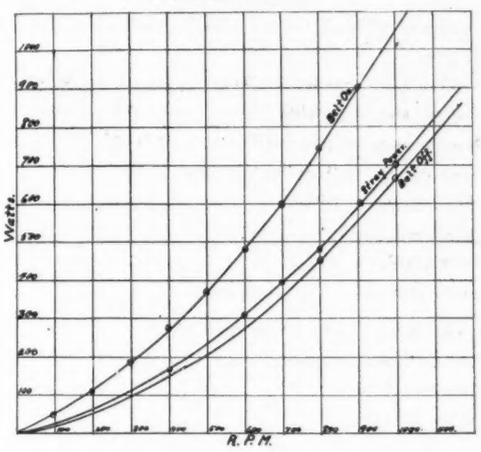


FIGURE 81.

as a motor. The field excitation of the direct current machine is kept at the same value as during the load test and the speed varied between the required limits by adjusting the voltage of the armature. Readings are then taken of volts and amperes input to the motor and a curve plotted showing the power required to drive the combination at several speeds. This is called the "belt on" curve. (See Figure 81.)

STRAY POWER CURVES.

The belt is then thrown off and similar readings taken at the same field excitation to find the power required to drive the direct current machine when running light at the required speed.

A curve of these results is plotted as the "belt off" curve. These are shown in Figure 81.

Let W_1 = watts required to drive the direct current machine running free as obtained from the "belt off" curve.

W_2 = watts required to drive combination of direct current machine and induction motor as given by "belt on" curve.

L = core loss in direct current machine.

F = friction of direct current machine running light.

F_1 = friction of induction motor running light.

f = friction of direct current machine due to belt tension.

f_1 = friction of induction motor due to belt tension.

Then from the "belt off" curve we have

$W_1 = L + F$ (1) and from the "belt on" curve

$W_2 = L + F + F_1 + f + f_1$ (2)

Subtracting (1) from (2) we get

$W_2 - W_1 = F_1 + f + f_1$

or $W_2 - W_1 - F_1 = f + f_1$ (3)

There is no accurate way of determining the relative values of f and f_1. As the machines are usually of the same capacity with bearings designed accordingly, it is a very close approximation to assume $f = f_1$, in which case we have

f or $f^1 = \frac{1}{2}(W_1 = W_1 - F_1)$ (4)

The friction running light from the induction motor, or F_1, has been previously determined by wattmeter measurement, the impressed voltage being gradually reduced until the induction motor core loss approaches zero. All of the quantities in the right hand member of equation (4) being then known, f is readily obtained and is added to W_1 to give the total stray power. A curve showing the variation of this stray power with speed is then plotted and the value at any required speed can thus be obtained.

Finally if C = amperes load on the generator, E = its terminal volts and R = the resistance of its armature we have

Counter torque = $W_1 + f + C^2R$ and for the lotal load on the induction motor

$W = CE + C^2R + (W_1 + f)$

or $W = CE + C^2R + S$ where S is the stray power.

The readings may be taken in the following log:

Volts Armature	Amperes Armature	Amperes Field (Constant)	D. C. Machine		Stray Power	R. P. M.
			C. E.	C^2R		

Kilowatt output	Horsepower output	Induction Motor		Per cent. synchronous	Power factor
		Common efficiency	Approximate efficiency		

Plot the above results as in Figure 82. Running torque is always found from the formula

$$T = \frac{33{,}000 \times \text{H.P}}{2\pi \times \text{R. P. M.}}$$

TORQUE, SPEED CURVES.

The theory and plotting of these curves will be found in Steinmetz Elements, pages 274 and 275, and also in the "Phenomena," page 267.

They are taken by means of the stray power method as in the case of the load curves, or preferably by means of the brake method, if possible.

It may be impractical to apply full voltage to the motor. In this case, reduce the voltage and correct the

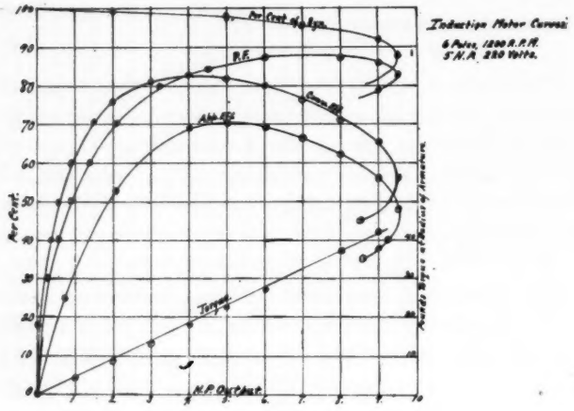


FIGURE 82

torque in the ratio of the squares of the voltages. Also the test should be taken with all starting resistance out.

Record the results as follows:

Volts	Amperes	Amperes field constant	D. C. Generator		Stray power	Speed
			C. E	C^2R		

Kilowatt output	Horse-power	Revolutions per minute	Induction Motor		Volts	Current
			Torque	Per cent. synchronous		

Plot the amperes and torque as in Figure 83, the torque being that at one foot radius.

$$\frac{33{,}000 \times \text{H. P.}}{2\pi \times \text{R. P. M.}}$$

A better way to plot torque is in terms of synchronous watts. This may be derived from the watts output

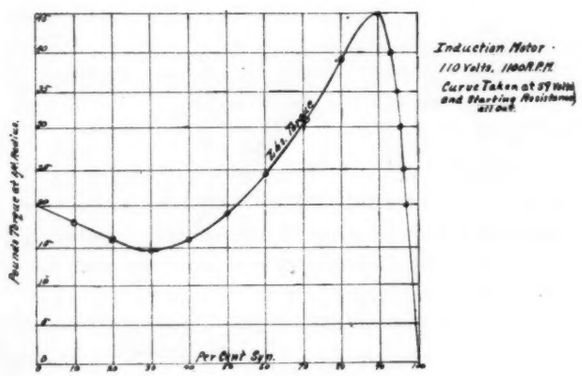

Induction Motor
110 Volts, 1800 R.P.M.
Curve Taken at 57 Volts and Starting Resistance all Out.
Pounds Figures at ft. Radius.
Per Cent Syn.

FIGURE 83

by multiplying the latter by 1 | 1—S where S is the slip. Then plot curves as shown in "Elements," page 274. Plot also the torque, efficiency, power factor and amperes.

An excellent check on the accuracy of a test is furnished by the "Heyland Diagram*" In fact, the diagram constructed from a few simple tests on the unloaded motor gives sufficiently accurate results for most practical purposes. An example of the use of the diagram is given in the following for a one horsepower, three phase, four pole motor, wound for 220 volts. The tests were made and the curves drawn for me by O. S. More.

The known values from which the diagram is constructed are:

1. Volts, amperes and watts input at no load.
2. Volts, amperes and watts input with rotor locked.
3. Resistance of the primary winding.

The test on the motor at no load gave,

Volts between lines..... 220
Amperes (line)..... 95
Watts (total)..... 53 2
Power factor = 14.7 per cent.

With the rotor locked the test gave

Volts between lines = 105
Amperes (line)..... 6.52
Watts (total)..... 2100

The current for full voltage would therefore be

$6.52 \times \frac{220}{105} = 13.7$ amperes, and the total watts will be, very nearly,

$13.7 \times \sqrt{3} \times 220 \times .592 = 3085.$

Referring now to Figure 84, draw the line AB and assume that it represents the direction of the primary impressed electromotive force. With A as center draw the quarter circle $B\,P$ with any convenient radius. This radius is equal to 100 per cent. on the power factor scale shown in the figure. $A\,P\,D$ is drawn perpendicular to $A\,B$. The power factor at no load = 14.7 per cent; draw the point P_1 on the circle $B\,P$ so that the perpendicular distance from P_1 to $A\,D$ = 14.7 divisions of the power factor scale. The line $A\,P_1$ gives the direction of the no load current. Similarly line $A\,P_2$ gives the direction of the short circuit current. Assuming a convenient current scale these lines also represent the magnitudes as well as the directions of these currents. We then obtain two points E_1 and E_2 on the input circle. It will usually be sufficiently accurate to draw a semicircle through these points and D from a center located on the line $A\,D$. More accurately on account of the resistance of the primary winding the center is on a line shifted from the line $A\,D$ through an angle E. This angle is found as follows:

Energy current at no load = $\frac{53.2}{220 \times 1.73}$ = .14 amperes.

*Eine Methode zu Exprimentellen untersucherngen an Induitionsmotoren.

Magnetizing current $i_m = \sqrt{\overline{\quad}^2 - \overline{\quad}^2} = .94$ amperes.

$.95^2 - .14^2$

The resistance of the primary being 2.7 ohms,

$$\text{Sin } \frac{E}{2} = \frac{\sqrt{3} \times 2.7 \times .94}{220} = .02$$

and $E = 2^\circ\ 18'$ and the center of the circle is at C, the semicircle passing through the three points E_1, E_2 and D. Draw $E_2 D$. Since the output is zero with rotor locked, this line is tangent to the output circle. Therefore draw $D\ C_2$ at right angles to $D\ E_2$. Its intersection with the line $C\ C_2$ gives C_2 the center of the output circle $D\ F_2\ F_1\ E$.

A point K on the torque circle may be located as follows:

Let AD also represent phase volts, in this case 127 volts. From this we find the scale of volts shown in the figure. The ohmic drop per phase in the stationary test is,

$$2.7 \times 13.7 = 37 \text{ volts.}$$

Lay off on line $E_2\ D$ the distance $E_2\ K = 37$ volts and the line DK represents the armature drop. A circle drawn through DK and E gives the torque circle the ordinates of which give the torque. The ordinate at K gives the starting torque.

At any point N of the line $D\ F_2$ draw a line $N\ M$ so that the angle $N\ M\ D =$ angle $D\ K_2\ E$. Let the distance $N\ M$ represent 100 per cent. slip. We thus have scales for volts, primary amperes, per cent. power factor and slip. The scales for watts, secondary amperes, and pounds torque are derived as follows.

E_2 is a point on the input circle, the perpendicular distance to AD being proportional to the watts input when the rotor is locked. But the watts required on short circuit were 3085. Hence the scale of watts is as shown.

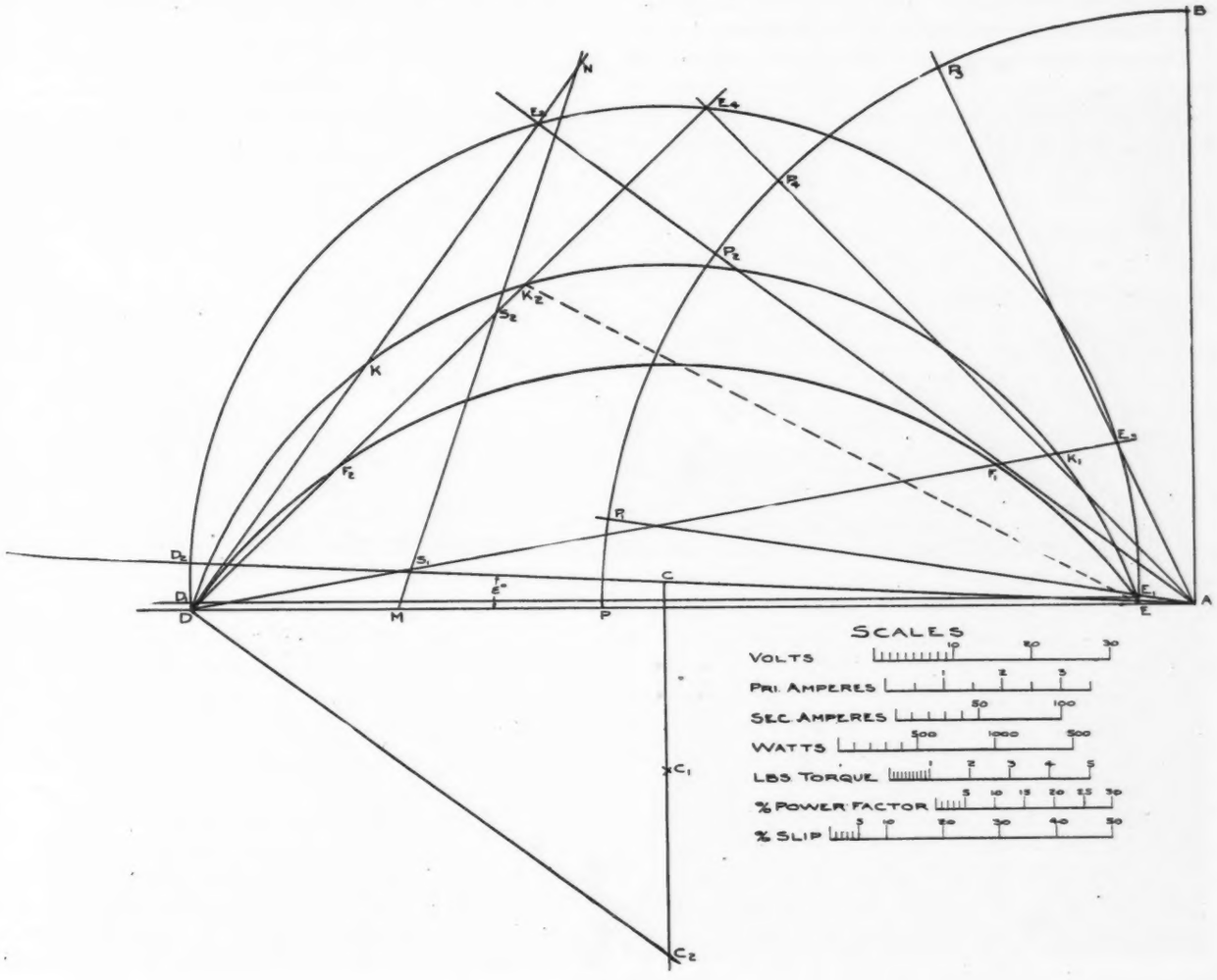


FIGURE 84

The torque circle gives the output in synchronous watts or in pounds torque at one foot radius as desired. The scale for synchronous watts is the same as the output or input watts already found.

At 1800 revolutions per minute the speed at one foot radius is $2 \times \pi \times 30 = 188.4$ feet per second. Torque at one foot $= \frac{550}{188.4} = 2.94$ pounds per horsepower. Hence 2.92 pounds torque $= 746$ synchronous watts and one pound $= 255$ synchronous watts.

The secondary current scale may be found as follows:

Secondary current $=$

$$\frac{\text{Primary current} \times \text{total primary conductors}}{\text{total secondary conductors}}$$

$$\times\left(1+\frac{O}{2}\right)\times K$$

where O = leakage coefficient $=\frac{AE}{AD}$ = .06 in this core, and K = .96 (Heubach, page 302)

Number primary slots = 36

Number conductors per slot = 46

Number of secondary conductors = 46

Hence secondary current = primary current

$$\times\frac{36\times 46}{46}\times 1.03\times .96 = 35.6 \text{ amperes.}$$

We thus have the secondary scale of amperes.

The total losses at no load = 53.2 watts, and in finding the output, this value is always subtracted from the value found from the output circle. The line $E_1 D_1$ is drawn parallel to AD and since $E E_1$ represents the total watts at no load the distance between the line AD and line $E_1 D_1$ represents the constant losses. This value is to be included in watts derived from the input circle but subtracted from the watts derived from the output and torque circles.

The efficiencies, power factors, etc., for any load are then found for the one horsepower motor as follows:

Assume the motor to be giving 850 watts brake output. The total watts delivered will be 850 + 53.2 = 903.2 watts.

Two points on the output circle F_1 and F_2 correspond to this output. Through these points draw lines from D and extend them until they intersect the input circle at E_3 and E_4. The ordinate corresponding to E_3 = 1040 watts and the efficiency is 87.6 per cent. Draw AE_3 extending it until it interests the power factor circle at P_3. The perpendicular distance from P_3 to AD = 90.5 per cent.

The primary current for the same load corresponds to AE_3 = three amperes.

The line DE_3 intersects the torque circle at K_1, and the synchronous watts are 906 or the pounds torque are 3.55.

The line DE_3 intersects $M N$ at S_1 and the distance $M S_1$ = 7.1 per cent. slip. The chord from E to E_3 is proportional to the secondary current = 98 amperes. Similarly we obtain values of efficiency, power factor, torque, slip, primary and secondary current for the second point F_2, from E_4, P_4, K_2, S_2 and the chords AE_4, EE_4.

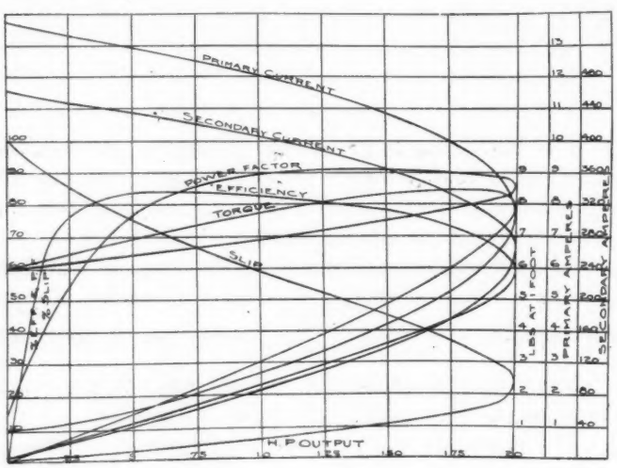


FIGURE 85

By assuming various outputs the other values can be derived from the diagram and a complete set of curves plotted. These are shown in Figure 85.

In Figure 86 is shown the close agreement between the dotted curves obtained from actual brake tests and the full line curves obtained from the diagram. The diagram assumes constant resistances of stator and rotor

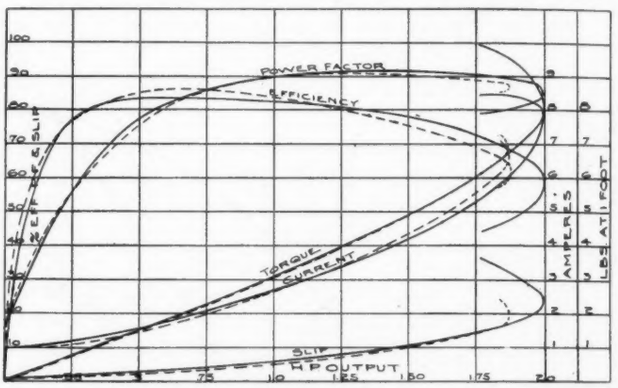


FIGURE 86

equal to the values at full load. On account of temperature variations the resistances are not quite constant, thus causing a crossing of the curves at about the full load values. Load losses are not included in the diagram. These were small in the case under consideration.

TELEPHONE ADVERTISING.

IN the ad reproduced herewith, from the Atlanta, Ga., *Journal*, is a mighty good scheme to get some good advertising material and at the same time to introduce the telephone into five new homes. All it costs the company is the installation of five phones and the service for a year; then the investment begins to pay a direct return, for it is very unlikely that even one family out of the five will be willing to give up the phone after a year's enjoyment of its many conveniences, but will continue its service at the regular rental. Incidentally it focuses the attention of every contestant and his or her friends upon the telephone, leads them to consider its advantages and reminds tham, the more they think about it, how necessary it is to the business and social life of today.

FIVE TELEPHONES FREE.

We will install a telephone connected by direct line with our exchange, and furnish unlimited residence telephone service, free for one year, to the five persons residing within the limits of our Atlanta exchange who send us, in writing, on or before January 1, 1906, the best reasons why a Bell telephone should be in every residence.

This contest is open to everybody except employees of the company.

Reasons must be written on one side of the paper only and must be limited to 100 words.

A person may enter as many reasons as he chooses.

The contest will be decided by a committee of disinterested business men of Atlanta.

Address "Best Reasons Contest," Traffic Department, Southern Bell Telephone Company, Atlanta, Ga.—From *Printer's Ink*.

THE PLANT OF THE VANCOUVER POWER COMPANY LTD.

BY WYNN MEREDITH.
PAPER NO. 2.

IN designing the Vancouver Power Company's installation, the present demand for electric power, as well as the natural annual increase as shown by the records of the old station, was considered. Accordingly, it was decided to install the initial equipment for 9000 horsepower in three units. Convenience of handling and independent unit operation favored separate pipe lines. Each unit consists of one revolving field engine type 200 revolutions per minute, three phase, 2300-volt Westinghouse generator, and two Pelton water wheels, one on either end of the shaft, taking water from a single pipe through a Y connection and two deflecting needle nozzles, one to each wheel; the shaft bearings and bed-plate being furnished by the water wheel makers. The needles are adjustable by hand to suit the maximum fluctuation of load and the nozzles deflected by type Q Lombard governors.

The revolving fields were especially designed and constructed to withstand a runaway speed which might accidentally reach 175 per cent. or more. The hollow forged steel shaft carries the rotor centrally between the bearings, making a perfectly symmetrical arrangement and loading the two bearings equally.

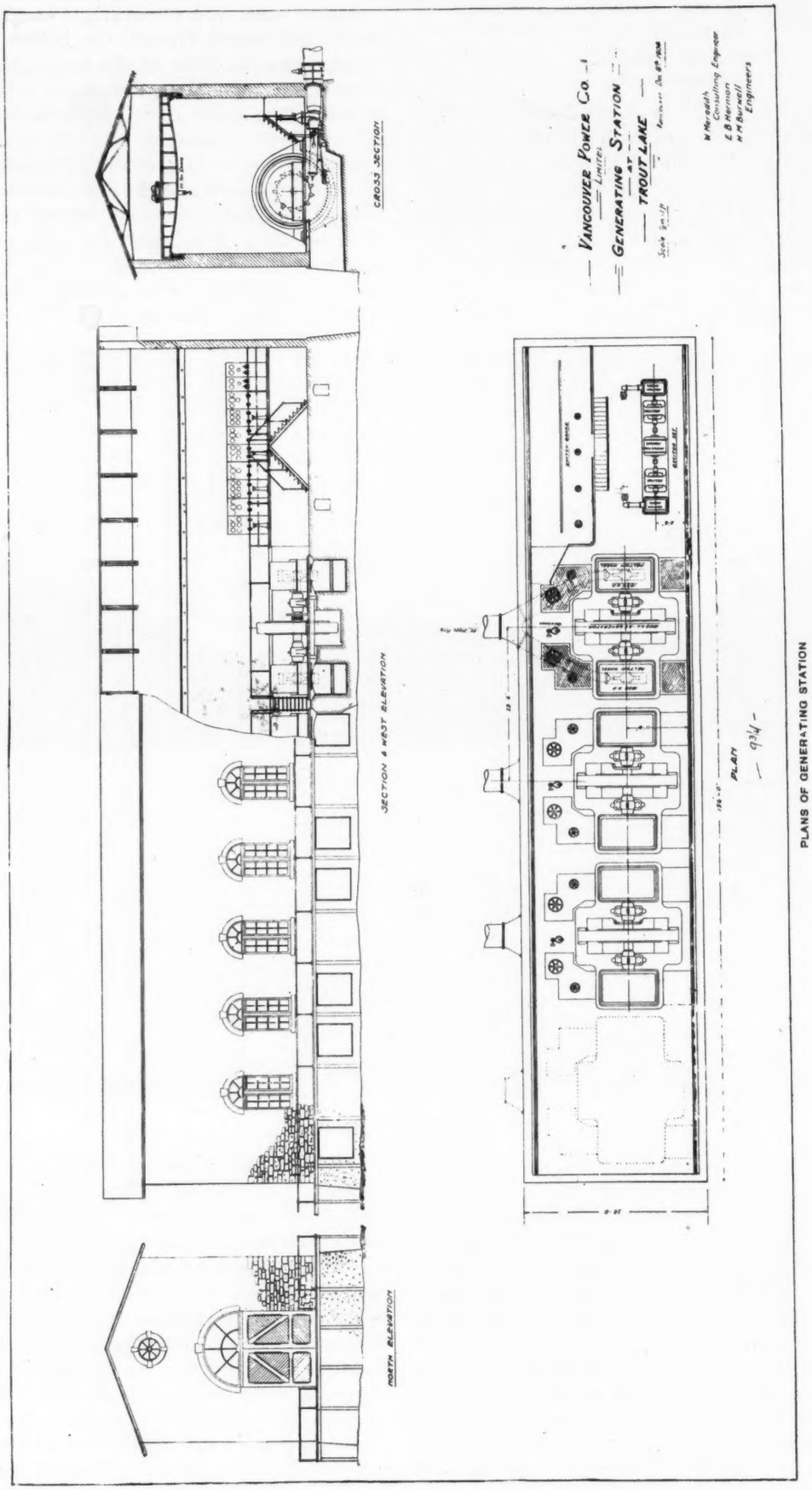
Spatter water from the wheels is caught in a housing pocket and passed through the hollow shaft and also through the oil cellar of the bearings. The rotating element, including shaft, wheels and field weighs 80,000 pounds. The water circulation system has proved of great value in maintaining cool bearings.

Exciting current is provided by means of either one of two direct connected water wheel driven generators, coupled to an induction moter, taking current from the main bus bars. The motor rot only insures exciting current in the event of wheel trouble, but serves as a governor absorbing as a generator the power of the wheel in excess of that required by the exciter.

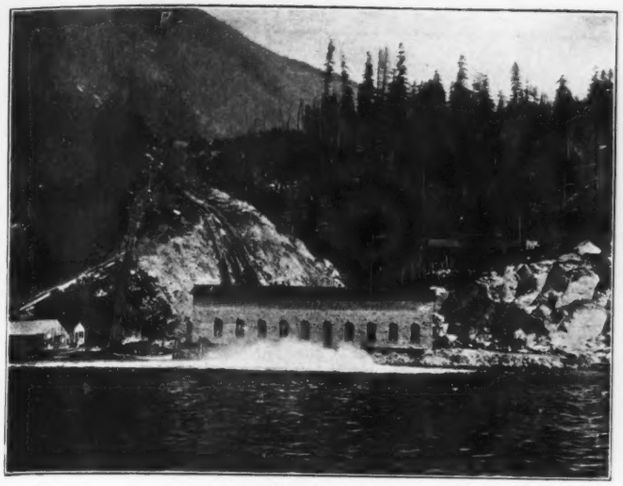
NORTH ARM OF BURRARD INLET

The equipment is housed in a plain massive granite building, forty feet in width and 160 feet in length, located just above high tide. As the granite bluffs extend almost vertically from the water edge, it was necessary to excavate a sort of shelf, not only for the present building, but for such future extensions as may be necessary to house the apparatus for an ultimate capacity of 30,000 to 40,000 horsepower. Much of the excavated rock was landed directly in the water by the force of the blasts, the water immediately in front of the works being over 600 feet in depth.

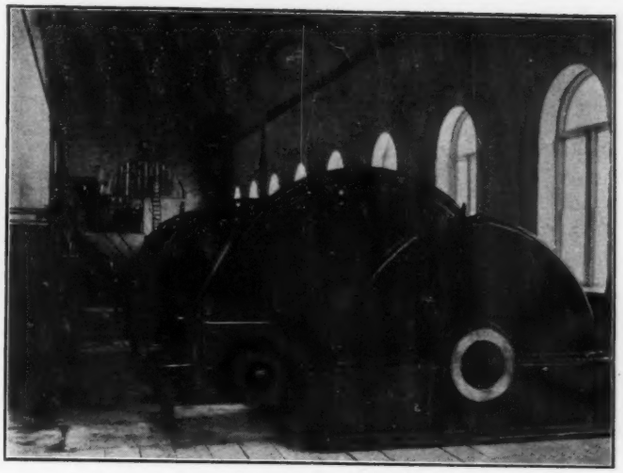
Foundations are provided for the addition of a fourth unit of similar size and design, beyond this only excavation for power house extension has been provided. It



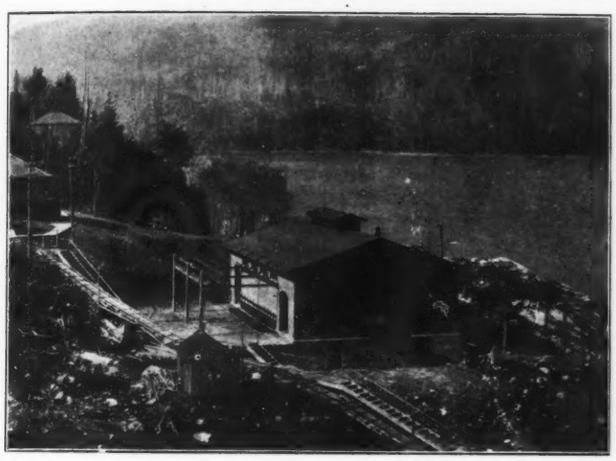
PLANS OF GENERATING STATION



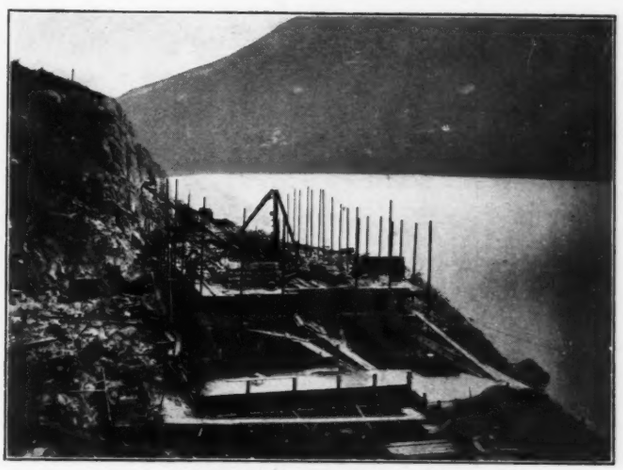
ENERAL VIEW OF PLANT



INTERIOR VIEW OF GENERATING STATION



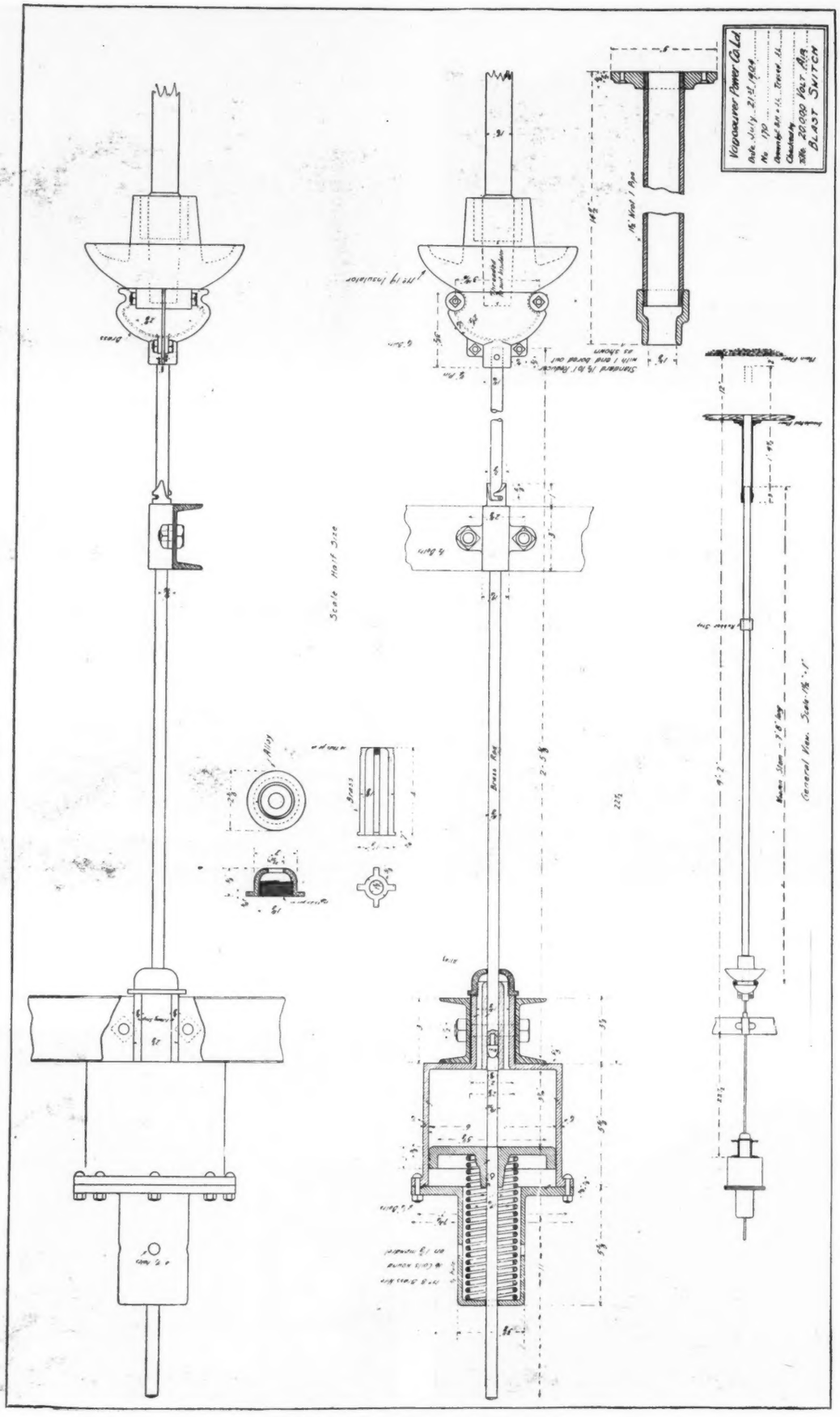
TRANSFORMER BUILDING



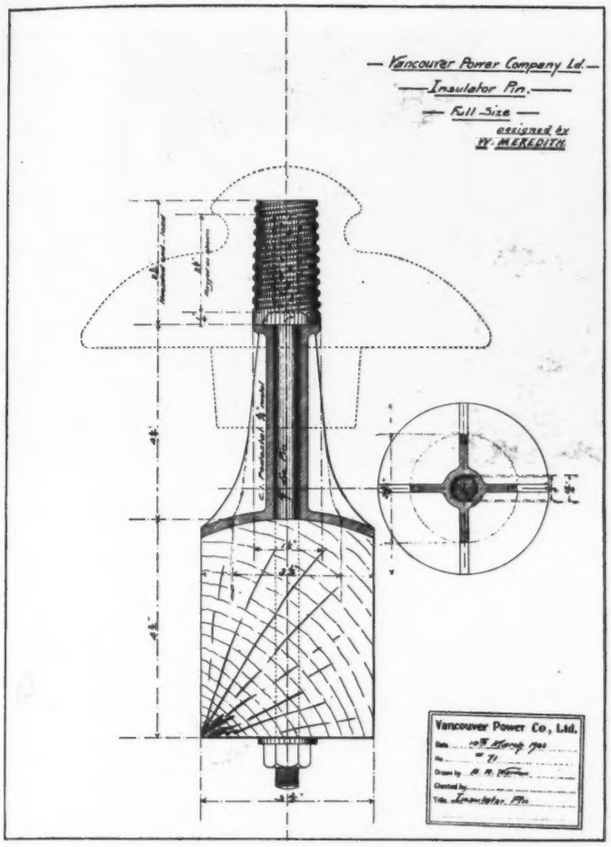
POWEP HOUSE UNDER CONSTRUCTION

GENERATING STATION

RAMSHORN SWITCHES



DETAILS OF HIGH POTENTIAL AIR BREAK SWITCH



METAL PIN

is probable that further additions will consist of 6000 horsepower units or larger

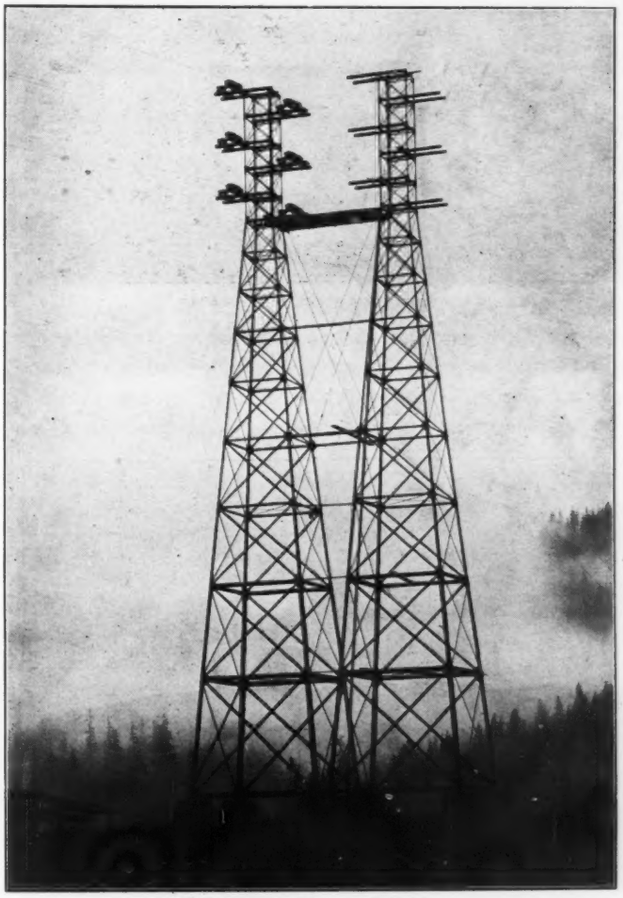
The switchboard is located upon a raised platform at one end of the building, affording the operator a complete view of the main floor. The board is of the usual construction, equipped with Tirrill regulators, a full set of indicating and recording instruments and automatic oil switches. Two sets of bus bars are provided, one for the constant lighting load and one for the variable railway and power service. Two single throw switches are used in place of the usual double throw switch, one connected to each set of bus bars. This permits of transfering a generator from one bus to the other or feeding them in parallel without opening the circuit, thus providing great flexibility and insuring smooth service.

In a concrete building on a small flat just above and back of the power house is installed the step-up transformers, high potential switches and lightning arresters. There are three sets of three 550-kilowatt air blast, delta connected, transformers, raising the voltage to 23,000 for transmission. The low potential side of these transformers is controlled by switches located on the main switchboard in the power house. The high potential side may be connected to either or both of two sets of bus bars and the four transmission circuits may in the same way be connected to either or both sets of buses.

The many switches required for this multiplicity of connections are of special design, made at the company's

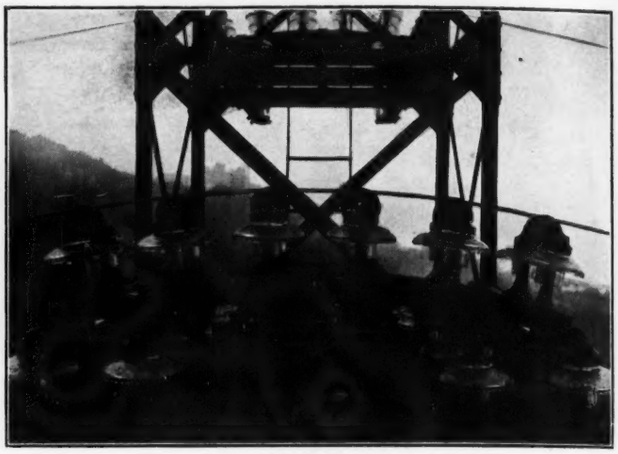
VIEW ON THE TRANSMISSION LINE

works, and are perhaps of more than passing interest. They are of the bayonet air break type, and contain no oil. When a switch is closed the bayonet compresses a spring behind a piston which furnishes a slight blast of air at the precise moment the bayonet is withdrawn, thus blowing out the arc before any considerable metalic vapor is formed. The arc appears to be about one and one-fourth inches in length when breaking a 2000-kilowatt 23,000-volt circuit. Westinghouse low equivalent lightning arresters are connected to each line,



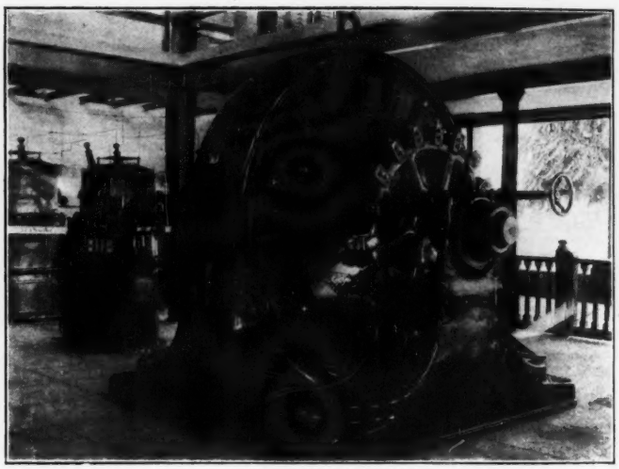
TOWERS AT BARNET CROSSING

ANCHORAGE FOR BARNET CROSSING



CABLE SADDLE ON TOWERS

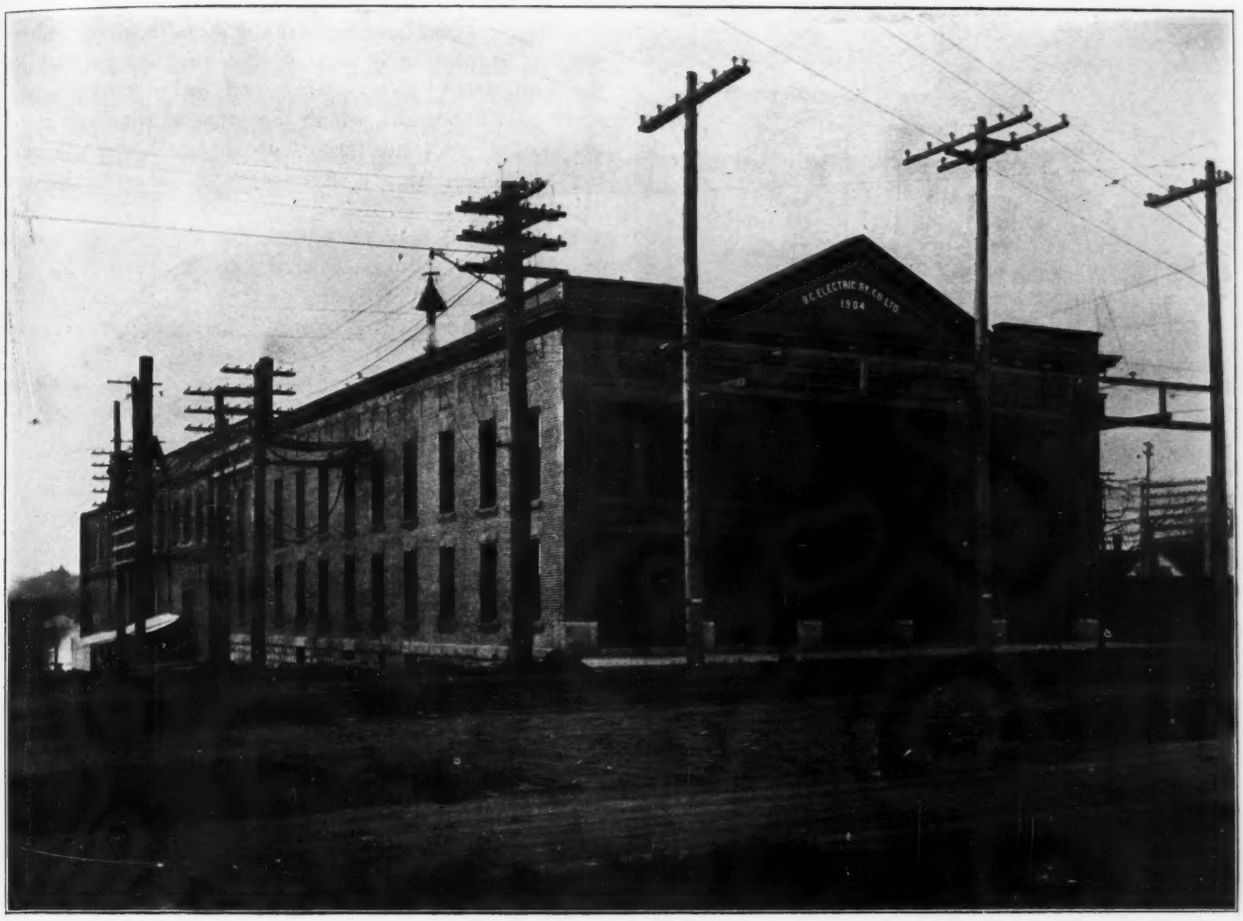
ANCHORAGE INSULATION ON LONG SPAN



ONE OF THE ROTARIES

GENERAL VIEW OF BARNET CROSSING

BACK OF RAILWAY SWITCHBOARD



VANCOUVER SUBSTATION

which is also provided with an ampere meter and a potential tell-tale.

Immediately outside of the transformer building there is inserted in each line a set of ram's horn emergency switches, which are operated from either in or outside points.

The double forty-five foot pole line carries four three phase, No. 2 B. & S. gauge, medium drawn, copper circuits, two on each line. The wires are supported on nine-inch umbrella type Locke glass insulators, mounted on a special metal pin. At corners and points of extra strain the insulators are provided with a cast iron cap cemented on. The clearing of the right of way through the extremely large timber of the dense forest, characteristic of this locality, was an expensive piece of work not usually met with in transmission line construction. For 100 feet in width the right of way was slashed, the brush and tops being burned and the immense logs rolled to either side. Outside of the 100 foot line all trees that might reach the line in falling, and there were many of them over 200 feet in height, were cut. The line from the power house to the Barnet crossing is built over a rough mountainous country, where wagon roads are impossible. Fortunately, there was found magnificent cedar growing on or near the right of way, from which all poles were cut. The cost of clearing alone amounted to $860.00 per mile.

At Barnet the lines cross a navigable arm of the harbor. The distance between supports is 2750 feet and the conductors are 150 feet above high tide at the lowest point. Twelve, seven strand nine-sixteenth-inch galvanized plow steel cables are used as conductors. High ground on the north shore and twin towers on the south shore form the supports of the doubly insulated saddles holding the cables. Each cable is anchored to eye bolts at either end. These are sulphured in solid rock on the north end and secured to a concrete monolith at the

BACK VIEW OF LIGHTING SWITCHBOARD, VANCOUVER SUBSTATION

TRANSFORMERS AT VANCOUVER SUBSTATION

south end. Anchorage insulation for each cable is secured by means of a series of thirty-two of the nine-inch, glass, line insulators, which are provided with cemented iron caps and supported by metal pins held in a double angle iron frame. The insulators are mounted in pairs, the cable passing between them. The strain is transmitted to the insulators by means of a clamp on the cable behind an equalizing bar, which transmits the strain to an insulator on either side, equally distant from the cable, by means of two U bolts having a curve of slightly greater radius than the neck of the iron insulator cap. This design permits the use of ordinary line insulators for almost any span, and it is worthy of note that any insulator can be replaced quickly and without difficulty.

From Barnet the line is constructed along the highway almost due west nine miles to Vancouver. Three miles from Barnet one line runs south to the Burnaby substation, located on the tramway connecting the city of New Westminister with Vancouver, and thence along the railroad right of way to Vancouver, forming a loop. In this way the Vancouver and Burnaby substations are served by two independent pole lines and four circuits.

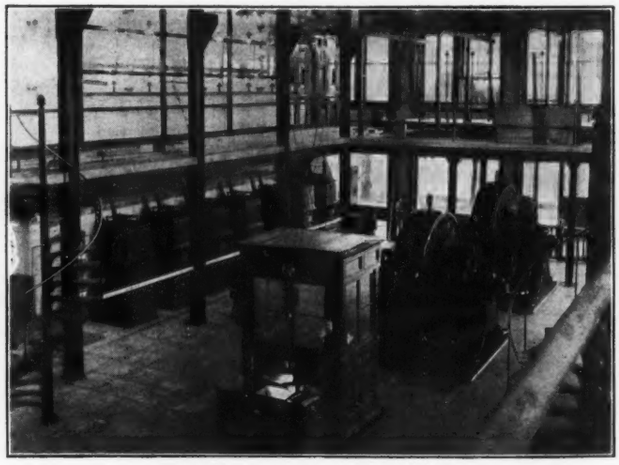
A four mile branch line from Burnaby to a substation in New Westminister supplies the municipally owned, distributing lines with current for both incandescent and street arcs. From Vancouver a branch line extends seventeen miles to the delta of the Frasier River, where another substation is located that supplies current for the Lulu Island electric road and lighting and power service for Stevetown where the large salmon canneries are located. All substations are of steel and masonry construction, designed for small fire hazard and low depreciation.

Transmission lines are all equipped with ram's horn disconnecting switches, located just outside of the buildings and arranged for operation from the inside. Flexibility of connections is obtained by means of a set of single pole automatic air blast switches in each station, which permits of any combination of circuits being made. From these switches two sets of high potential bus bars provided with low equivalent lightning arresters, are carried to the step-down transformers, which are all of the air blast type.

The Vancouver substation is located on Westminister Avenue, one of the principal streets of the city and is a fine, substantial building 60x120, with large plate glass windows facing the avenue. In addition to the basement and main floor, there is a steel and concrete floored gallery, eighteen feet wide on the front and both sides. The air blast switches occupy the front portion of the gallery and the lightning arresters and transformer switches are located on one side the railway switchboard being on the other. Spiral stairs give ready access to the gallery on either side. The open space in the middle is reserved for rotary converters, and is provided with a hand operated bridge crane traveling the length of the building.

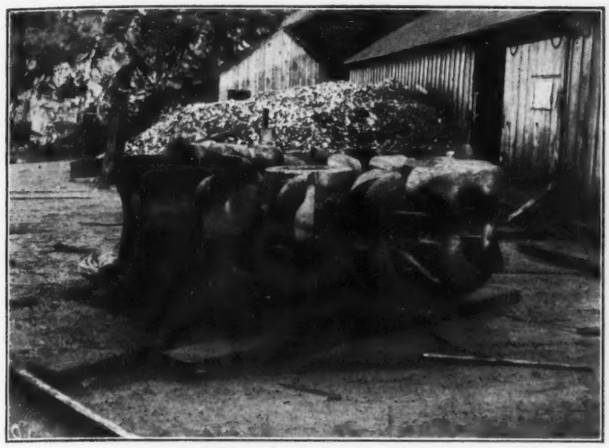
Railway current is provided by means of two 500-kilowatt and one 1000-kilowatt rotary converters, with their complement of transformers, regulators and switchboard. Each rotary is provided with a direct connected induction starting motor and a direct current rheostatic starting equipment. The switchboard contains both alternating current and direct current rotary panels, a totalizing panel and feeder panels.

The lighting and power service in Vancouver is supplied by means of eight 500-kilowatt step-down trans-



VANCOUVER SUBSTATION FROM GALLERY

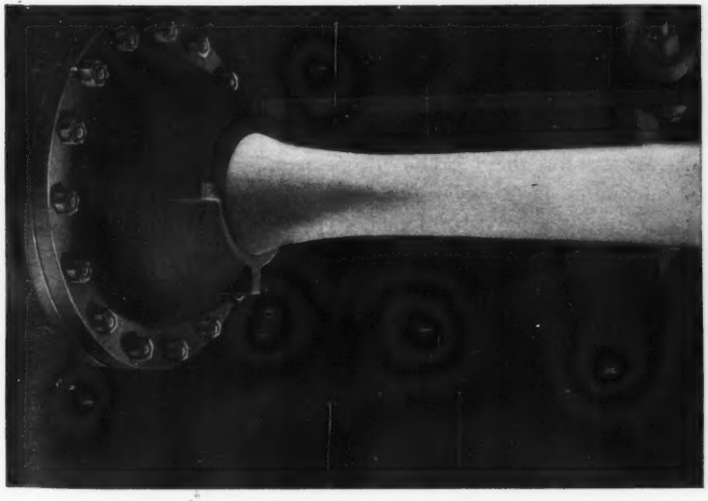
formers, "Scott connected" for two phase, 2300 volts. Current from these transformers is taken through a sixteen panel switchboard, provided with a full complement of instruments and switches. The single phase feeder circuits are each provided with a double throw oil switch for connection to either phase for balancing purposes, a



ONE OF THE WATER WHEEL RUNNERS

time limit controlled oil circuit breaker and independent regulators. Recording voltmeters are used on each feeder, taking current from a pair of pressure wires connected at the center of distribution.

The first generator was started, and current delivered, December 19, 1893, water for the wheels being obtained from Trout Lake. The tunnel was completed and water delivered through it June 10, 1905. Commercial service has been given since the first unit was started, only one interruption having been noted to date, and that was caused by one of the large wood rats, which are found in this locality, having attempted to build a nest between two of the anchorage insulators at the Barnet crossing. The iron caps used on the insulators were partially fused, but prevented any injury to the cable. A few moments only were required in which to disconnect both ends of this line when service was resumed over the three remaining circuits. From this experience it would seem that rats and similar animals will have to be counted a menace to electrical transmission lines, as well as birds.



Simplicity and durability were the chief factors considered during the design and construction of the plant. Its operation to date has demonstrated that in a large measure both have been attained to perhaps a greater extent than has been usual on the Pacific Coast.

The principal contractors connected with the undertaking were: Ironsides, Rannie & Campbell, Tunnel; Westinghouse Electric and Manufacturing Company, electrical equipment; Pelton Water Wheel Company, water wheels; Lombard Governor Company, governors; Vancouver Engineering Works, pipe lines and head gates; Jno. Martin & Co., insulators; Canadian Rand Drill Company, air drills; Geo. Leyner Company, air compressors; in addition to which a great many contracts were placed with local firms for the smaller machinery, supplies, etc. The steel towers and cables used at the Barnet crossing were made in England and brought out via China.

For the complete study, design, execution and management of the undertaking the official staff was exceedingly small. J. Buntzen, general manager; Wynn Meredith, consulting engineer; R. H. Sperling, engineer representing the British Columbia Electric Railway Company's interests; H. M. Burnwell, engineer in charge of dams and pipe lines; E. B. Hermon, engineer in charge of tunnel; M. C. McKay, engineer in charge of power house.

To the general manager and the engineers the writer wishes to express his appreciation of those qualities which made it possible to complete and put into successful operation such a large undertaking in so short a period.

TELEPHONES IN CABOOSES.

IN order to doubly safeguard traffic on the Oregon Railroad and Navigation Company's line, a system of telephones will be established all over the line in connection with the telegraphic communication.

E. A. Klippel, superintendent of telegraph, is supervising the installation of the telephones, and the work will be completed as rapidly as possible. Telephone instruments and induction coils will be installed in each telegraph office along the line, and cabooses will be equipped with telephone instruments. When the telegraph line gets out of order between stations, or when a train meets with an accident or delay, a wire can immediately be attached from the caboose to the telegraph wire and communication established between the train, no matter where it is, and the nearest telegraph office.

In this way orders can be sent to conductors while on the road between stations, and many costly and annoying delays avoided.

It will require about one hundred phones for offices and a like number for cabooses to equip the entire system, and the cost will be considerable.

THE EVOLUTION AND DEVELOPMENT OF THE STEAM LOCOMOTIVE AS EVIDENCED BY THE EXHIBITS IN THE TRANSPORTATION BUILDING AT THE ST. LOUIS WORLD'S FAIR.*

BY WILLIAM A. DOBLE.

PART III.

It is a 3-cylinder, 12-wheeled, 4-coupled compound express locomotive built for the Prussian State Railway and exhibited by its builders, Henschel & Son, of Cassel, Germany. This machine represents the latest development of a heavy high-speed locomotive in Germany, and was designed with much care in every detail. The excessive speeds obtained on the Berlin-Zossen line with electric cars have caused the locomotive designers in Germany to put forward every effort for obtaining a steam locomotive which would be able to rival the electric, both in speed and capacity, and this engine is the result from the works of Henschel & Son. While there was not time for a thorough test before shipping it to St. Louis, on the trials made this engine drew a train weighing 180 tons at a speed of eighty-one miles per hour.

The odd exterior appearance, as shown in the illustration, caused much comment and speculation from visitors at the exposition, particularly those not familiar with train resistances. The whole machine above the running board, including the tender, was inclosed in a continuous steel housing, which is tapered to a wedge-shape at the front end. The enormous amount of resistance caused by the air at very high speeds, which is one of the largest resistances to be overcome by the locomotive under ordinary circumstances, has been recognized by the designers, and this housing, with its continuous smooth sides and top and pointed end, offering but little chance for the air to obtain a hold, is expected to reduce this resistance by a large percentage.

The application of the housing made it necessary to place the engineer in front of the boiler, where he could have a clear view ahead. Inasmuch as there is a continuous enclosed passage from the engineer's cab to the rear of the tender and into the train, and there are two firemen employed, one working at a time, the usual objections to having the engineer alone in his cab do not hold in this case. The passageways are lighted by a number of windows, and in front there are four, of large double plate glass, which in addition to two on either side, make this compartment very light and give an excellent view of the track ahead.

The three cylinders are arranged with the high-pressure in the center line between the frames and connected to a cranked front axle, and the two low-pressure outside the frames connected to pins on the rear drivers. The two low-pressure pistons work together at an angle of 90 degrees to the high-pressure crank. This arrangement was used to prevent any tendency of unbalanced reciprocating parts to cause the locomotive to revolve around a verticle axis or to "nose" as this motion is called in American railroad parlance, and which might prove dangerous in operating at high speeds. All three cylinders are 20⅝-in. diameter by 24⅞-in. stroke.

There are many interesting features embodied in the design of this locomotive, but lack of time prevents mentioning them. The engine weighs in working order 85 tons, 32 tons being on the 86⅝-in. drivers.

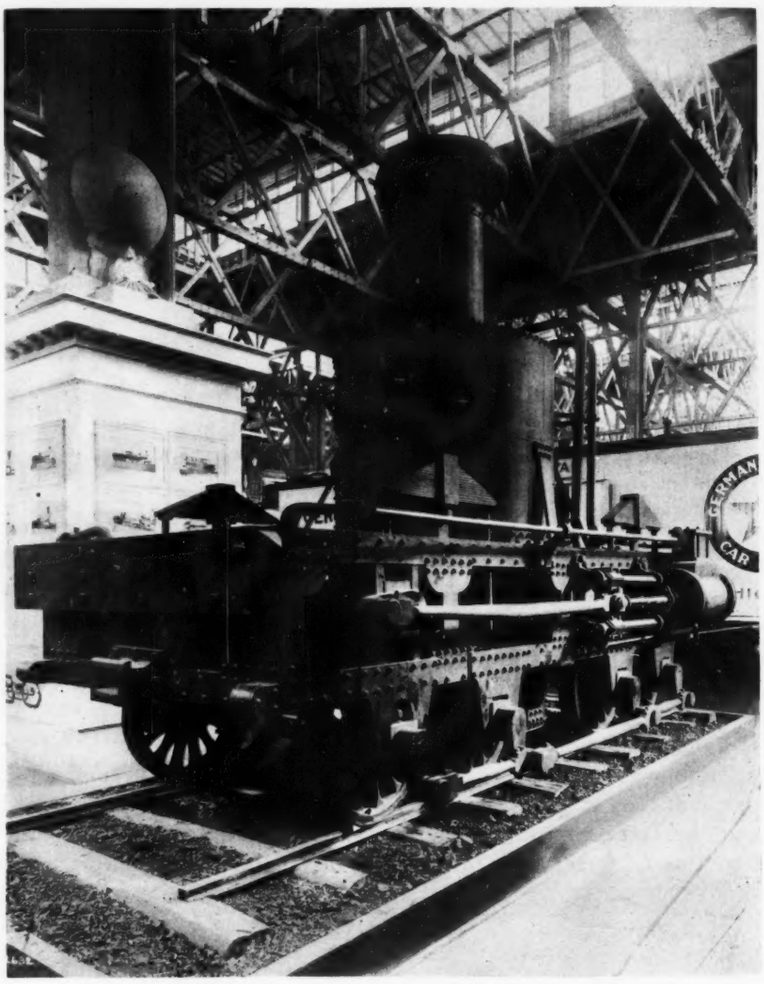


FIGURE 47. "BUFFALO," FIRST EIGHT-WHEELED COUPLED LOCOMOTIVE, WINANS, 1844

A remarkable locomotive, both in design and workmanship, built by the Elsaessische Maschinenbau-Gesellshaft at its Belfort works in France, was exhibited by the Pennsylvania Railroad Company. This locomotive shown in Figure 66 is a four-cylinder balanced compound of the De Glehn type and was purchased by the Pennsylvania Railroad as an example of the latest and highest type used on French railways in fast passenger service. The reputation of this type of engine for power and economy is well known, and the opportunity to study the construction

*A paper read before the Pacific Coast Railway Club, San Francisco, Cal., September 16, 1905.

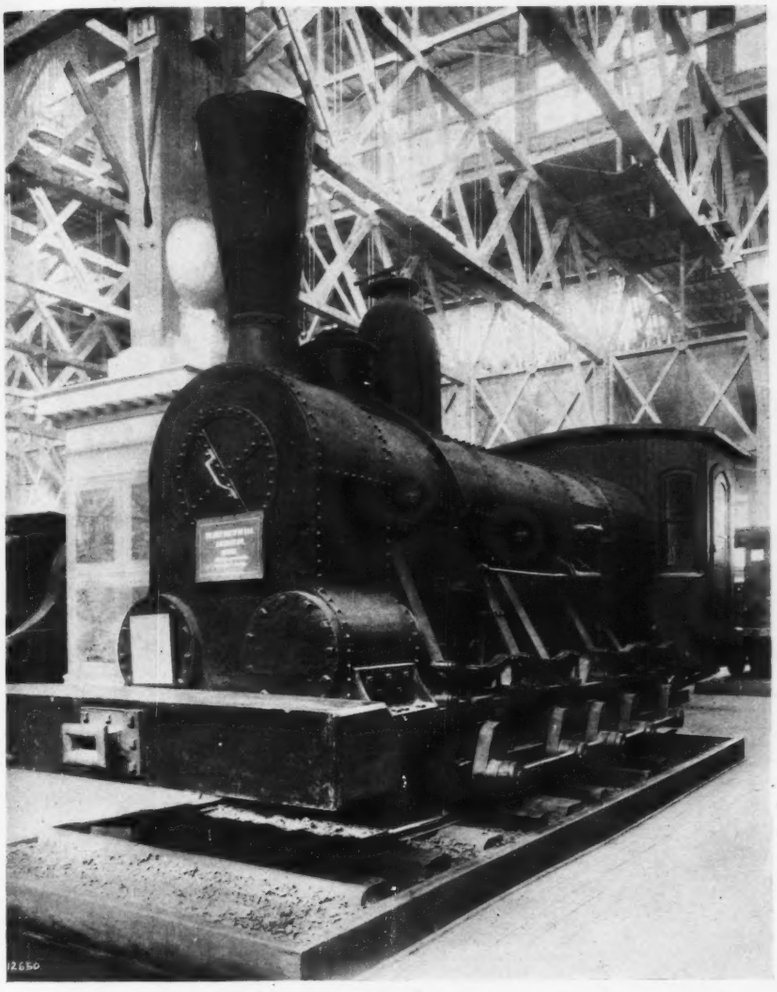


FIGURE 48. "MOUNT CLARE," FIRST LOCOMOTIVE BUILT BY THE B & O. R. R., MURRAY, 1845

In operating compound the steam is admitted to the high-pressure steam-chest through a steam-pipe outside the boiler and exhausts into a receiver consisting of a short pipe outside the frame which connects to a cylinder chamber forming part of the low-pressure steam-chest. The final exhaust is through an exhaust-pipe below the stack, having an adjustable opening which is controlled from the cab. Inside the cylindrical chamber of the low-pressure steam-chest is a rotating valve, in the form of a bushing, which is operated from the cab by air pressure. By rotating this valve through 90 degrees it allows the high-pressure cylinder to exhaust directly to the atmosphere. An auxiliary throttle in the cab will allow live steam to enter the low-pressure cylinder, thus making it possible to operate the locomotive in four different ways—either pair of cylinders working simple, both pairs of cylinders working simple, or both cylinders working together in compound. This engine weighs 160,000 lbs., of which 79,500 lbs. is on the 80-in. drivers. Its tractive effort is 16,900 lbs. when working compound.

Figures 67 and 68 illustrate two other types of locomotives from the Belfort Works. The smooth and clean-cut exterior finish of these foreign locomotives is particularly noticeable. Their working parts are generally lighter than on our locomotives, as the railroads abroad are not nearly as rough or curved as in this country, and from the actual locomotive was taken advantage of by mechanical engineers to a great extent throughout the exposition.

The high-pressure cylinders on the engine are outside the frames and connected to the rear drivers, while the low-pressure cylinders are located inside the frame in the same horizontal plane and connected to the front axle, which is cranked. This location is not a particular feature of the design as it is sometimes reversed when the low-pressure cylinders are too large to go between the frames conveniently. The outside cylinders are set back of those inside, giving nearly the same length main rod in both cases. Each cylinder has a separate valve, those for the high-pressure being balanced slide-valves, while unbalanced slide-valves are used with the low-pressure cylinders. These valves are driven by separate gears although both are controlled by the same reversing gear.

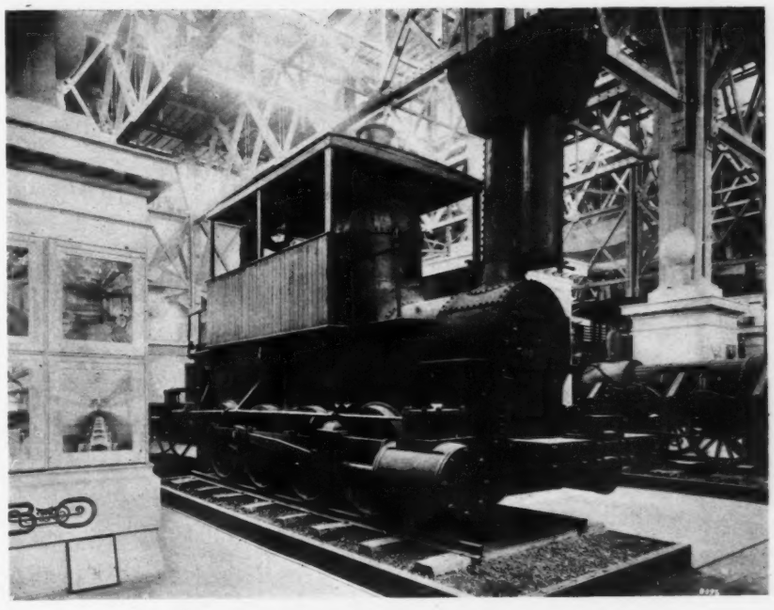


FIGURE 49. "CAMEL BACK," FIRST OF ITS TYPE, WINANS, 1848

therefore the locomotives are not taxed as much as ours. A disadvantage of these foreign engines is that most of their working parts are rather inaccessible, thus, necessarily increasing the cost of maintenance, and making it difficult to make repairs when an accident occurs on the road. Being lighter, the foreign engines will not stand up under hard usage as well as ours.

Figure 69 shows a four-cylinder balanced compound, Atlantic type, passenger locomotive built for the Prussian State Railway by the Hanover Locomotive Works. This locomotive was of particular interest to American railroad men for the reason that it uses superheated steam, being the only engine on exhibition that contained a superheater. The locomotive was also much admired for its handsome lines and very light-weight reciprocating parts.

The Von Borries system of compounding with which this locomotive was equipped differs from the De Glehn just described, in that the four cylinders are set in a line in the same horizontal plane and all connected to the front driver. The high-pressure cylinders are inside the frames and controlled by a piston-valve, while the low-pressure are outside and controlled by a balanced slide-valve. The inside cylinders connect to a cranked axle in the same manner as the De Glehn. In this engine both valves on the one side are actuated by the same valve-gear of the Hensinger-Walschaert type. There is but one eccentric connected to a single link, but the stem of each valve is coupled to an advance lever, which receives its motion from the cross-head of the corresponding piston. For the outside valve the link motion is transferred by a rod with levers of different length which are so proportioned that the ratio of steam admission is constant in both forward and backward gear.

The super-heater used was of the Pielock type, which has been in use abroad for some time with gratifying results.

In Figure 70 is shown a simple consolidation locomotive built for the Southern Pacific Company. This engine is slightly smaller, but of a very similar design to the consolidation locomotive of the New York Central. It has 22x30-in. cylinders, which, combined with its smaller drivers, 57-in. diameter, gives it nearly as much tractive force as the larger engine. Its weight is 207,340 lbs., of which 184,500 lbs. is on the drivers. Its tractive power is 40,800 lbs. The locomotive has a Vanderbilt tender holding 7,000 gals. of water and 14 tons of coal.

Figure 71 shows a simple consolidation locomotive built for the Delaware, Lackawanna & Western Railroad—the only one on exhibition built for burning hard coal. The fire-box being wide, 108¼ inches, makes it necessary to place the cab in the center of the boiler and to have an auxiliary cab at the rear for the fireman. While it is possible to enter the main cab from the rear along a running board on the fire-box, it is rather difficult, and the usual entrance is through the front door. The dome on this engine is far forward, ahead of the cab. Some designs have the dome in the center of the cab in about the usual location. The bell and auxiliary dome are back of the cab on the fire-box. Both injectors, air pump, and in fact all appliances needing attention are on the engineer's side of the boiler. The engine has a total weight of 191,500 lbs., with 171,700 lbs. on the 57-in. drivers, and a tractive effort of 32,200 lbs.

FIGURE 50. "DRAGON," FIRST LOCOMOTIVE EQUIPPED WITH ROCKING GRATE, BALDWIN, 1848

Both of these engines were built by the Baldwin Locomotive Works.

Figure 72 shows a two-cylinder compound consolidation locomotive built for the Norfolk & Western Railroad by the Baldwin Locomotive Works. This was the only example of a two-cylinder compound on exhibition and one of the few engines shown at St. Louis having a narrow fire-box. In this system of compounding the

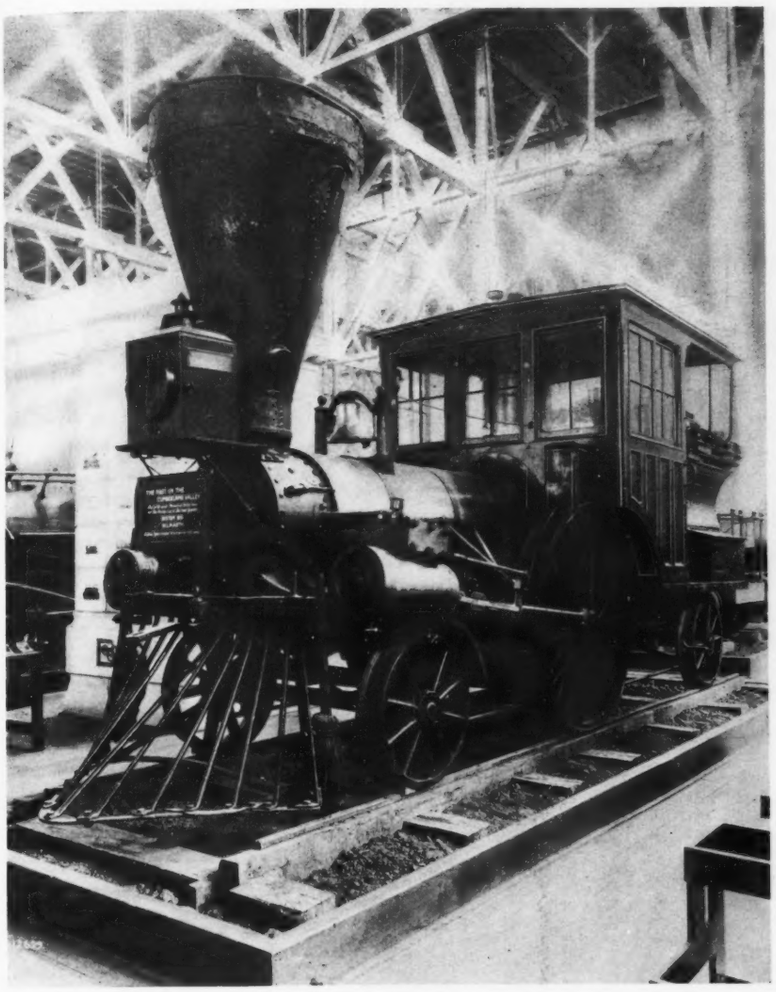


FIGURE 51. "PIONEER," FIRST IN THE CUMBERLAND VALLEY, WILMARTH, 1851

high-pressure cylinder is on the left side. Both cylinders have balanced slide-valves and very long valve-rods, passing through a bearing in the guide-yoke to the rocker-arm between the second and third pairs of drivers. The low-pressure piston has an extension piston-rod passing through the front cylinder-head which takes the weight from the bottom of the cylinder-bore. There is little difference in construction of the cylinders from a simple engine. The locomotive weighs 186,000 lbs., with 160,000 lbs. on the 56-in. driving-wheel. Its tractive effort is 34,000 lbs. operating compound.

Figure 73 illustrates a simple Pacific-type passenger locomotive exhibited by the Baldwin Locomotive Works and built for the Union Pacific Railroad. This was the heaviest passenger locomotive on exhibition and in many respects was the representative passenger engine exhibited. In construction it is a good example of modern practice in a locomotive design for pulling heavy passenger trains at high speed. The boiler is 70 inches in diameter, of the straight type, and contains 245 flues 2¼-in. diameter and 20 feet long. These are the longest flues in any boiler on a passenger engine which was exhibited and are exceeded in length only by those on the Mallet compound. A feature of this engine was the swing-motion controlling truck which is designed to give the greatest amount of flexibility to a long wheel-base locomotive. The engine weighs 222,520 lbs., of which 141,290 lbs. was on the 77-in. driving-wheels. Its tractive effort is 28,100 lbs.

In Figure 74 is shown the simple Atlantic-type locomotive built by the American Locomotive Company for the Big Four Railway. This locomotive was located in the center of the Transportation building on a drum-driver turntable. The locomotive drivers rested on small rollers which were driven from electric motors located inside the table and thus revolved the drivers at a moderate speed. This motion, in combination with the revolving of the table, the working of four automatic semaphores set around the circumference, and the lighted electric headlight and classification lamps made a very striking exhibit, and one that was constantly the center of a large crowd.

In construction, this locomotive differs a little from the others of the same type built by the same company. It has 20½x26-in. cylinder piston-valves, 79-in. driving-wheels with the Davis counterbalance and

FIGURE 52. TEN-WHEEL "CAMEL," FIRST OF ITS TYPE, HAYES, 1852

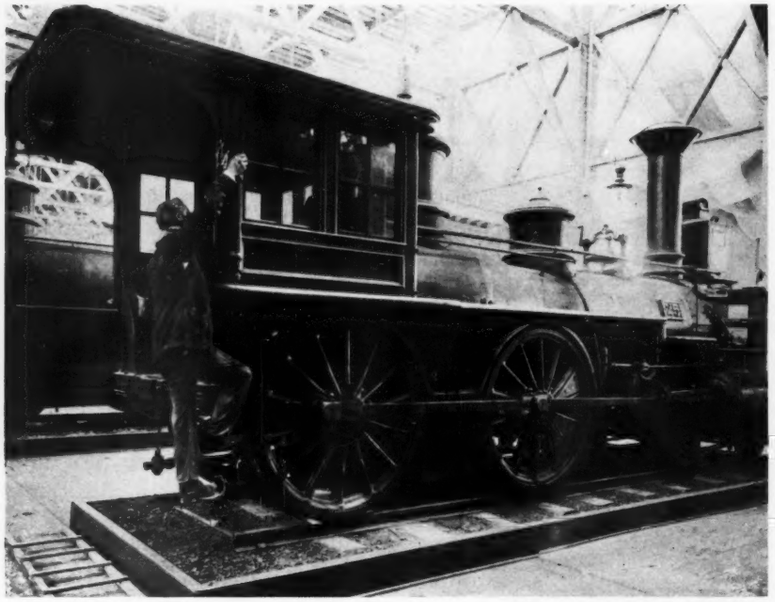


FIGURE 53. "MASON," EARLIEST EXAMPLE OF MASON TYPE, MASON, 1853

a trailing-wheel with inside journals. It weighs 184,000 lbs., with 100,000 lbs. on the drivers, and has a tractive effort of 22,100 lbs.

In Figure 75 is shown the simple Prairie-type passenger locomotive built by the American Locomotive Company for the Lake Shore and Michigan Southern Railway. You will notice that this engine is equipped with a two-wheel front truck, a design which, despite its acknowledged advantage of increased weight on the drivers, is not used as much as the four-wheeled truck. This is because the latter is considered safer at high speeds on the ordinary American railway, which usually has sharp curves, and also because it is much easier on both the machine and the track under those conditions. However, on such railways as the Lake Shore and Michigan Southern, which have but comparatively few curves, the design shown offers decided advantages and that it has been successful is proved by the fact that this Company, after three years' trial, has built and put into service many of the same general design. Comparing this engine with Union Pacific 4-6-2 type, just shown, you will note that while the latter has 63½ per cent of its weight on the drivers, this engine, while weighing but 190,200 lbs. total, has 142,700 lbs. or 75 per cent of its total weight on the drivers.

In construction, this locomotive illustrates very careful study and a successful solution of many different problems which, at the time it was designed had not yet been attempted.

Figure 76 shows a simple Mogul locomotive built for the St. Louis and Southwestern Railway by the Rogers Locomotive Works. It was one of two standard-gauge Mogul-type engines that were exhibited. This style of wheel arrangement is being forced out of use very rapidly on the larger systems in freight service because of the impossibility of putting the weight needed on three drivers, and in passenger service, because the wide fire-box with large wheels forces the boiler up too high. The type is most satisfactory for use with light freight trains or heavy slow-speed passenger trains, and it is for that class of service that this engine was built.

The grate area of this locomotive was the smallest of any road engine exhibited, but in other respects there was nothing unusual in its construction. The engine weighs

FIGURE 54. "PERKINS," FIRST HEAVY TEN-WHEEL LOCOMOTIVE, PERKINS, 1863

145,000 lbs., of which 127,000 lbs. is on the 61-in. drivers. Its tractive effort is 24,400 lbs.

In Figure 77 is shown a simple narrow-gauge Mogul locomotive, which was one of an order recently delivered

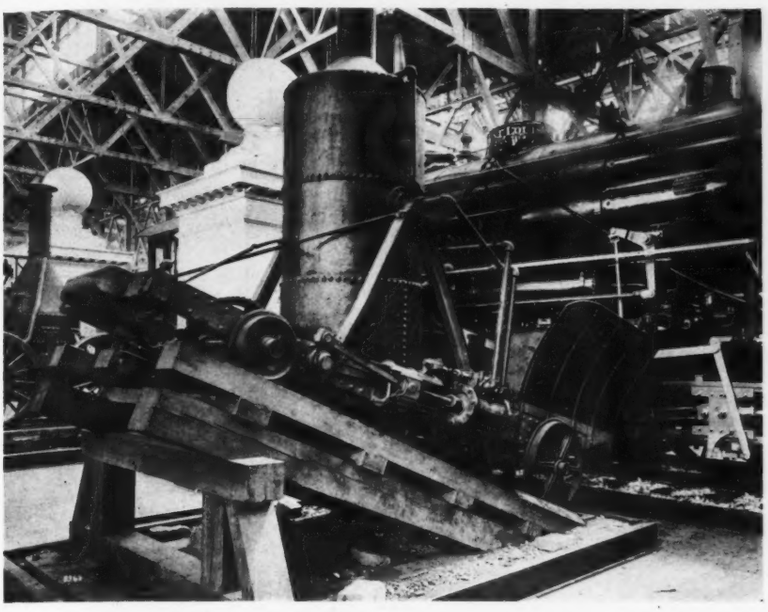


FIGURE 55 "PEPPERSAUCE," FIRST MOUNTAIN CLIMBING LOCOMOTIVE. MARSH, 1863

to the Kuishui Railway of Japan by the American Locomotive Company. It is a good example of American practice as applied for foreign conditions. The gauge is 3 ft. 6 in., which gives it a very narrow fire-box of only 29⅝-in. width. The tank has a peculiar wheel arrangement consisting of a four-wheel truck behind and a simple two-wheel truck ahead. The engine weighs 91,500 lbs. with 78,000 lbs. on the 54-in. drivers.

Figure 78 shows the only large switching locomotive on exhibition. It is a six-wheel engine and was built for the Manufacturers' Railway by the American Locomotive Company. Being painted in bright colors, with nickel and polished parts, fancy striping, etc., it attracted considerable attention. It was located in connection with a large beer-car, the two forming the exhibit of the Anheuser-Busch Brewing Co. In construction it is a good example of a strongly built switch engine for rough and heavy work. It weighs 143,000 lbs., and has 20x26-in. cylinders with piston-valves. The cab is set back further than is the practice on road engines and is very roomy. The locomotive has a tractive power of 30,000 lbs.

Figure 79 shows a Shay-geared locomotive, exhibited by the Lima Locomotive & Machine Company. You are doubtless familiar with this type of locomotive as several are in use on the Mount Tamalpais Railway and logging roads throughout the state. It is of especial advantage on roads having grades over 3 per cent, where its superiority over the direct-connected type is acknowledged.

The locomotive exhibited at St. Louis has three 12x15-in. cylinders and a 46-in. boiler with 11 ft. flues. It is built on center-bearing swiveled trucks, the locomotive frame with water and fuel resting on the trucks which are under each end, the entire weight being useful for adhesion, and distributed on eight or twelve drivers; this admits of using lighter rail and also allows its use on wood rail when necessity requires. The trucks with drive-wheels are free to swivel and vibrate independently of the locomotive frame, and thereby adjust themselves to curves and irregularities of the track with the least possible friction.

The power is conveyed from the engines to the drive-wheels by means of a horizontal shaft, in sections, each section provided with a universal joint and expansion couplings, forming a flexible shaft, which is rigid in revolution, but flexible in all other directions. On this flexible shaft are steel pinions pressed and keyed on, which engage the steel gear-rims, which are bolted to the right-hand drive-wheels of each track; the horizontal and crank-shafts are connected by means of the universal couplings, which have proved reliable and efficient.

The engines, all being on the right side, are firmly

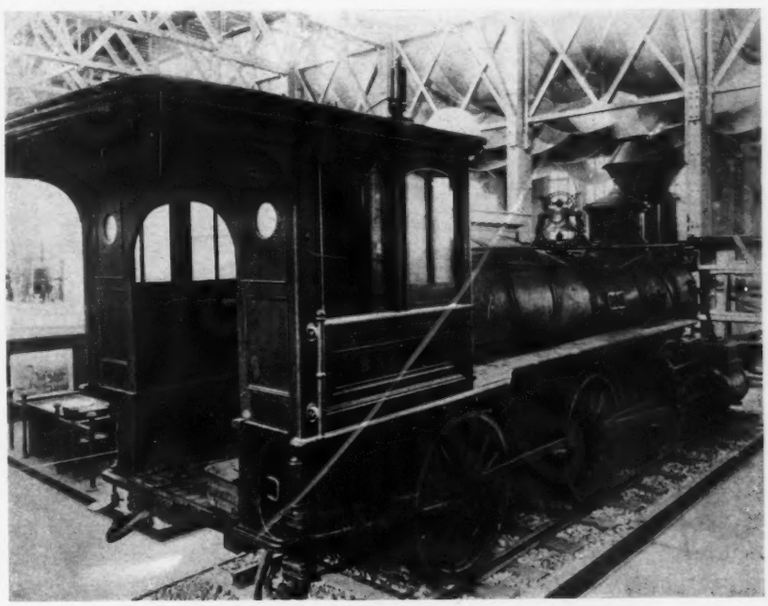


FIGURE 56. "B. & O. 600," FIRST MOGUL, EXHIBITED AT CENTENNIAL, B. & O., 1876

fastened to the boiler in an upright position, which secures to the cylinders the least possible wear. The equilibrium is gained by setting the boiler to the left of the center of the frame, thus giving the locomotive a perfect balance.

The locomotive weighs, in working order, 130,000 lbs., and its tractive force is 33,830 lbs.

Before passing to a review of the lessons to be learned by the locomotive exhibits at St. Louis, it is interesting to consider again the first locomotive, the automobile of Cugnot, and compare it with a steam automobile of modern manufacture. In Figure 80 is shown the 1906 White automobile model, and when its efficient design is compared with the Gugnot machine of 1769, (Figure 6) we realize that there has been a remarkable progress in the development of locomotives that travel on ordinary roads as well as those that move on rails.

The White machine shown in Figure 80 has a 114-inch wheel-base and weighs 2,270 lbs. The wheels are 34 inches in diameter and the gauge is standard, 4 feet 8½ inches. The frame of the running gear is made of wood strongly armored with sheet steel, thus making it resilient and pliable and at the same time amply strong. The body is made of aluminum, which, aside from being fire proof, is more durable, lighter and takes a better finish than wood.

The engine is a vertical compound steam engine with "D" slide-valves, fully encased and dust-proof. All parts of the engine, except the pistons and piston rods, run in an oil bath. Lubrication to the cylinders is by a force feed pump driven by a belt, and is entirely automatic, i. e., the oil feeds only when the engine runs. The drive is through a bevel-gear on the rear axle and is entirely encased and dust-proof. The engine bearings are ball-bearings throughout, as are also the running bearings, with the exception of one on each side of the driving-gear on the rear axle. These are solid bearings, necessarily made so because of the necessity of having them adjustable, in order that the gear may be adjusted to the pinion. The axle is of nickel steel, and all parts throughout are of the very best material for the purpose, regardless of the expense of construction, as quality and efficiency are the prime considerations.

An important feature of the car is the White steam generator, in which there is no water level and no hand regulation of the fire or water. The fire is regulated by a thermostat and the temperature is within 3 degrees Centigrade of constant at all times regardless of the pressure. The temperature of the steam supplied to the engine is 800 degrees Fahrenheit.

The generator is supplied with water through a water regulator operated by steam pressure, and as the temperature is constant, the amount of pressure depends upon the specific volume in the generator. The generator consists of a set of single steel tubes, which are tested to 3,000 lbs. hydraulic pressure.

The life of this steam generator plant is estimated at 10 times that of an ordinary boiler, and the cost of repairs and care is said to be not over one-tenth that of an ordinary boiler. The economy in fuel consumption owing to the highly superheated steam, which practically does away with the condensation in the engine, permits an expansion to 16 times the original volume before exhausting into the condenser.

In the 1906 car there is an increased efficiency in the burner, giving perfect combustion without forced draft. In this car there is no steam exhaust, no noise, no vibration, and it is said to be the lightest car on the market for its power and carrying capacity, thus making it much easier on tires. The car will run on good roads at a speed of 50 miles an hour with five people. A speed of 74 miles an hour has been attained with a White racing machine of the same type on a circular track—this being the world's record for a circular track.

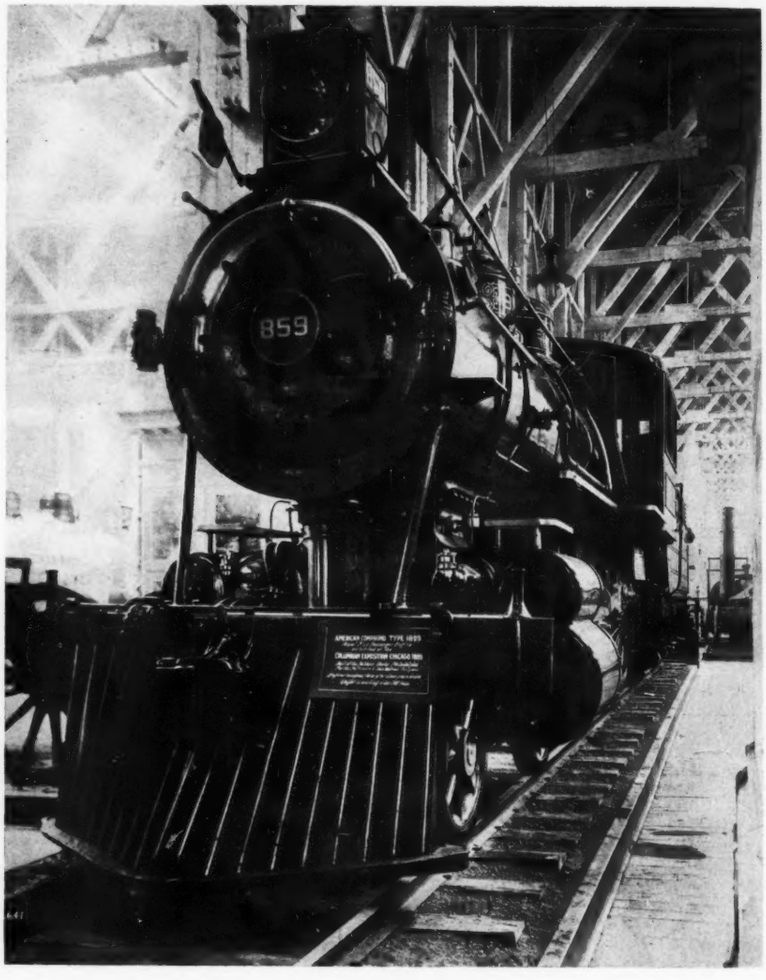


FIGURE 57. "DIRECTOR GENERAL," VAUCLAIN FOUR-CYLINDER COMPOUND, 1893

Summing up the lessons to be learned by a study of the modern locomotives exhibited at St. Louis we find their predominating features characterized by the word "bigness." This is especially apparent in the large boilers, wide fire-boxes, and high pressures. The cause of this

increase in proportions is explained by the constant seeking for economy in transportation, and since larger engines can haul larger train loads with consequent saving in expense for wages, the natural result has been the construction of larger and larger locomotives culminating in the giants exhibited at St. Louis. Whether this increase is to continue can only be told by future accomplishments.

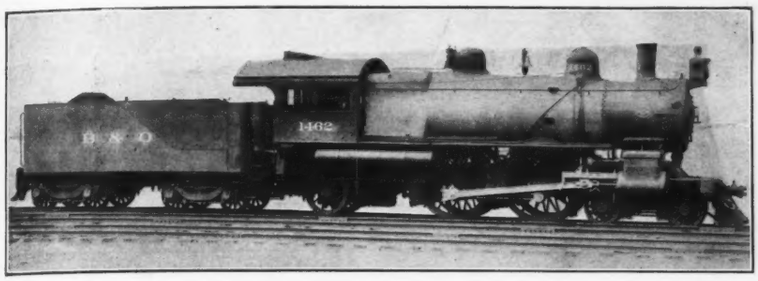


FIGURE 58. SIMPLE ATLANTIC TYPE, B. & O., AMERICAN LOCOMOTIVE COMPANY, 1904

Comparing the exhibits with those shown at the Chicago World's Fair, some very interesting facts are brought out. At the Chicago Exposition, in 1893, the 21 passenger engines exhibited averaged 122,270 lbs. total per locomotive, with an average of 85,000 lbs. on the drivers. The 18 freight engines averaged 133,061 lbs. per locomotive, with 111,133 pounds on the drivers. Compared with these figures we find the fifteen passenger engines exhibited at St. Louis average 185,546 pounds, total, with 113,092 pounds on the drivers, while the thirteen freight engines averaged 205,392 pounds total, with 183,980 pounds on the drivers. Excluding the Baltimore & Ohio Mallet articulated compound, which is not a freight engine, strictly speaking, the average was 194,633 pounds, total, with 171,437 pounds on the drivers. This shows an increase in the weight of passenger locomotives of over 51 per cent, total, and over 33 per cent on drivers in little more than a decade; and of over 54 per cent total, and 65 per cent on drivers of freight engines, if we include the Mallet compound or 46 per cent, total, and 54 per cent on drivers not including that locomotive.

These figures are indeed significant of the immense progress that has been made in the construction of the steam locomotive, and when we think of the pioneers who, throughout the last century, have labored unfalteringly and frequently against great and discouraging odds to make locomotion on land what it is to day, we do so with a feeling of respectful and profound reverence, for truly they wrought better than they knew.

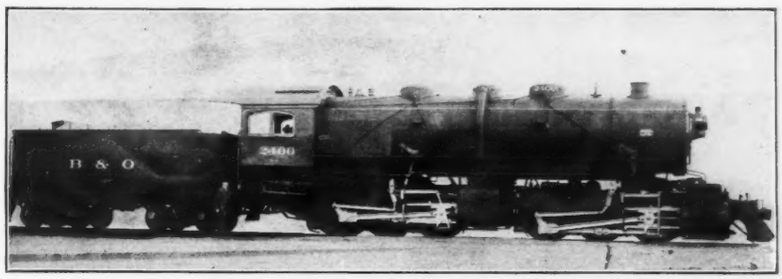


FIGURE 59. MALLET ARTICULATED COMPOUND, B. & O., AMERICAN LOCOMOTIVE COMPANY, 1904

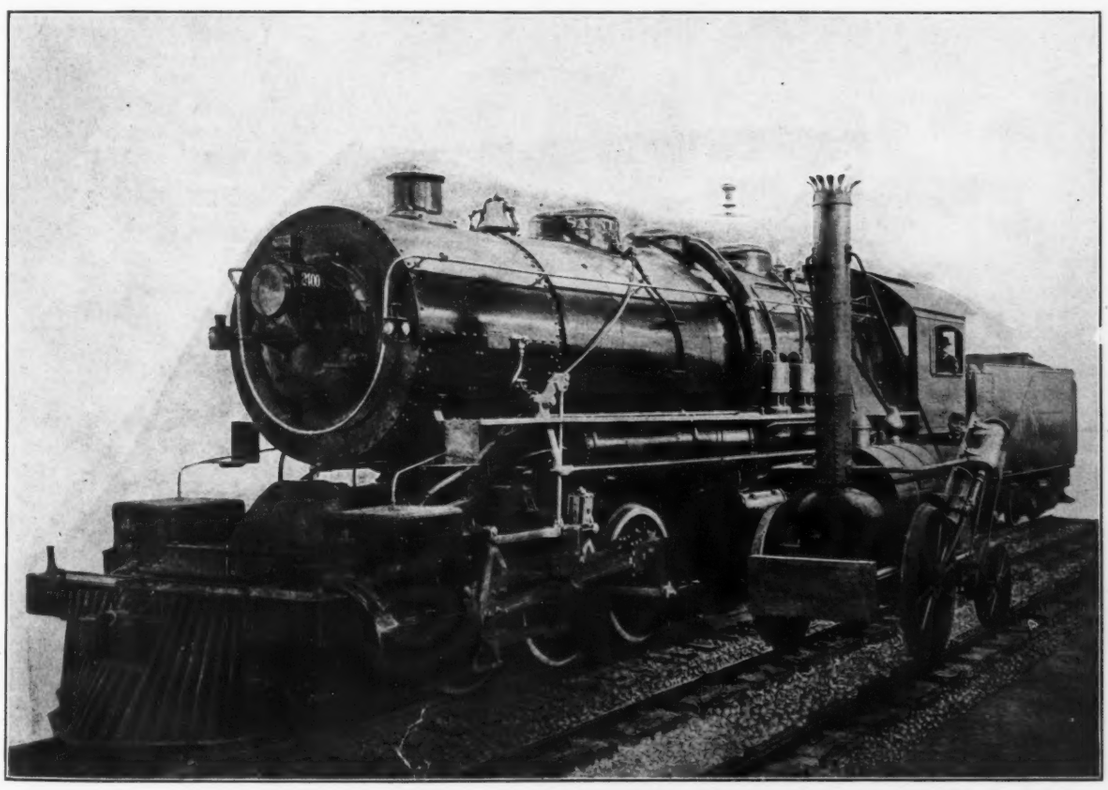


FIGURE 60. MALLET COMPOUND AND STEPHENSON'S "ROCKET," SEVENTY-FIVE YEARS OF LOCOMOTIVE CONSTRUCTION

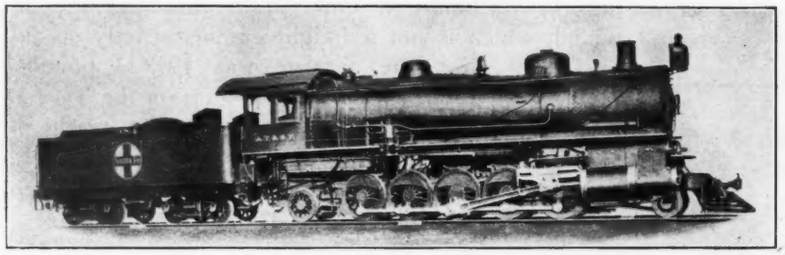


FIGURE 61. TANDEM COMPOUND, SANTA FE TYPE A. T. & S. F., BALDWIN, 1904

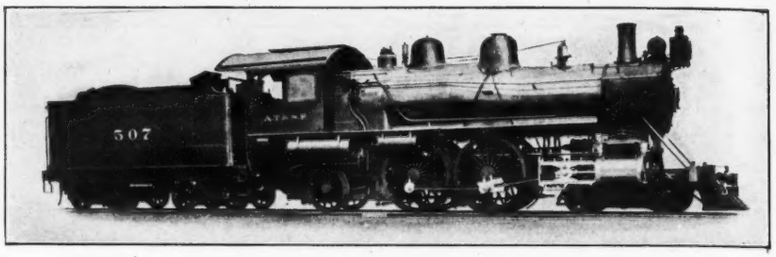


FIGURE 62. FOUR-CYLINDER BALANCED COMPOUND ATLANTIC, A. T. & S. F., BALDWIN, 1904

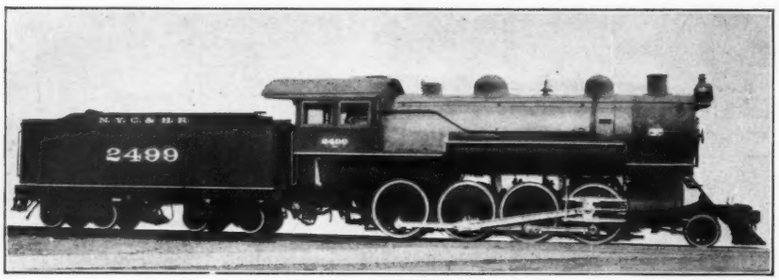


FIGURE 63. SIMPLE CONSOLIDATION, N. Y. CENTRAL, AMERICAN LOCOMOTIVE COMPANY, 1904

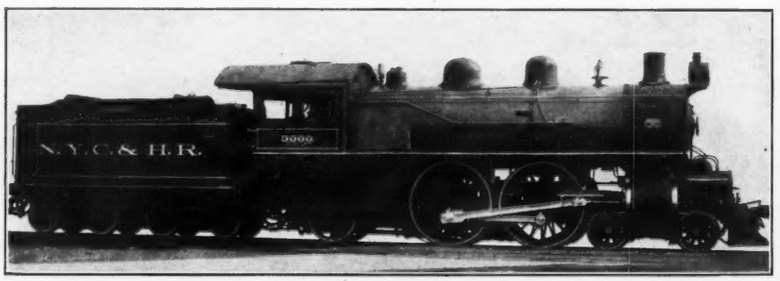


FIGURE 64. FOUR-CYLINDER BALANCED COMPOUND ATLANTIC, N. Y. CENTRAL, AMERICAN LOCOMOTIVE COMPANY, 1904

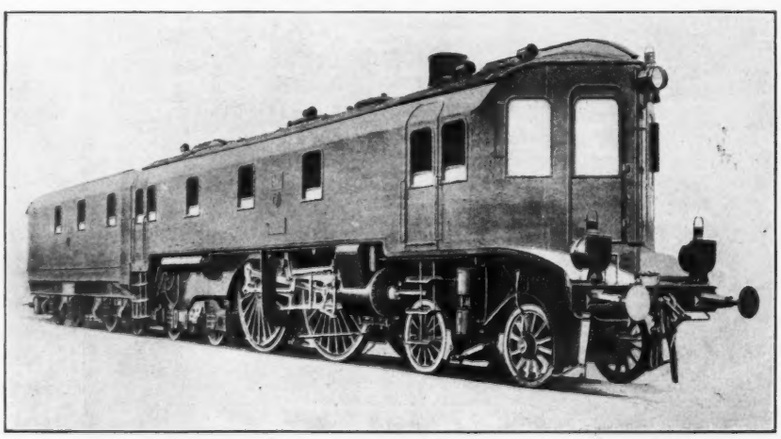


FIGURE 65. THEEE-CYLINDER, TWELVE-WHEELED, FOUR-COUPLED, COMPOUND, PRUSSIAN STATE RAILWAY, HENSCHEL, 1904

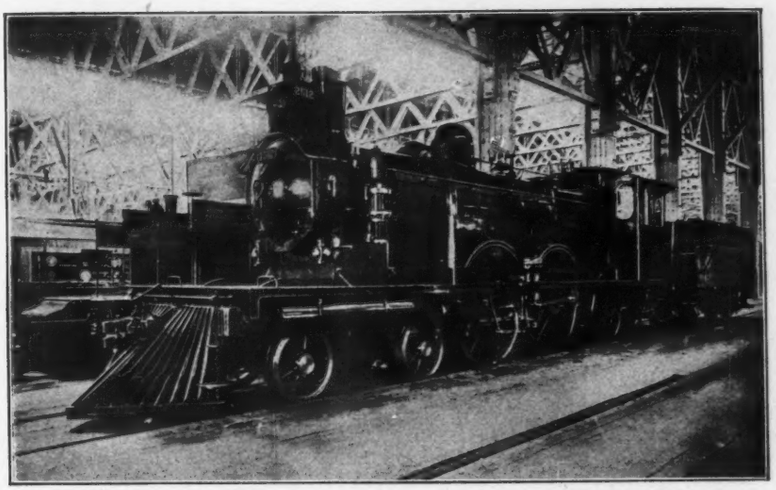


FIGURE 66. FOUR-CYLINDER BALANCED COMPOUND DE GLEHN TYPE.

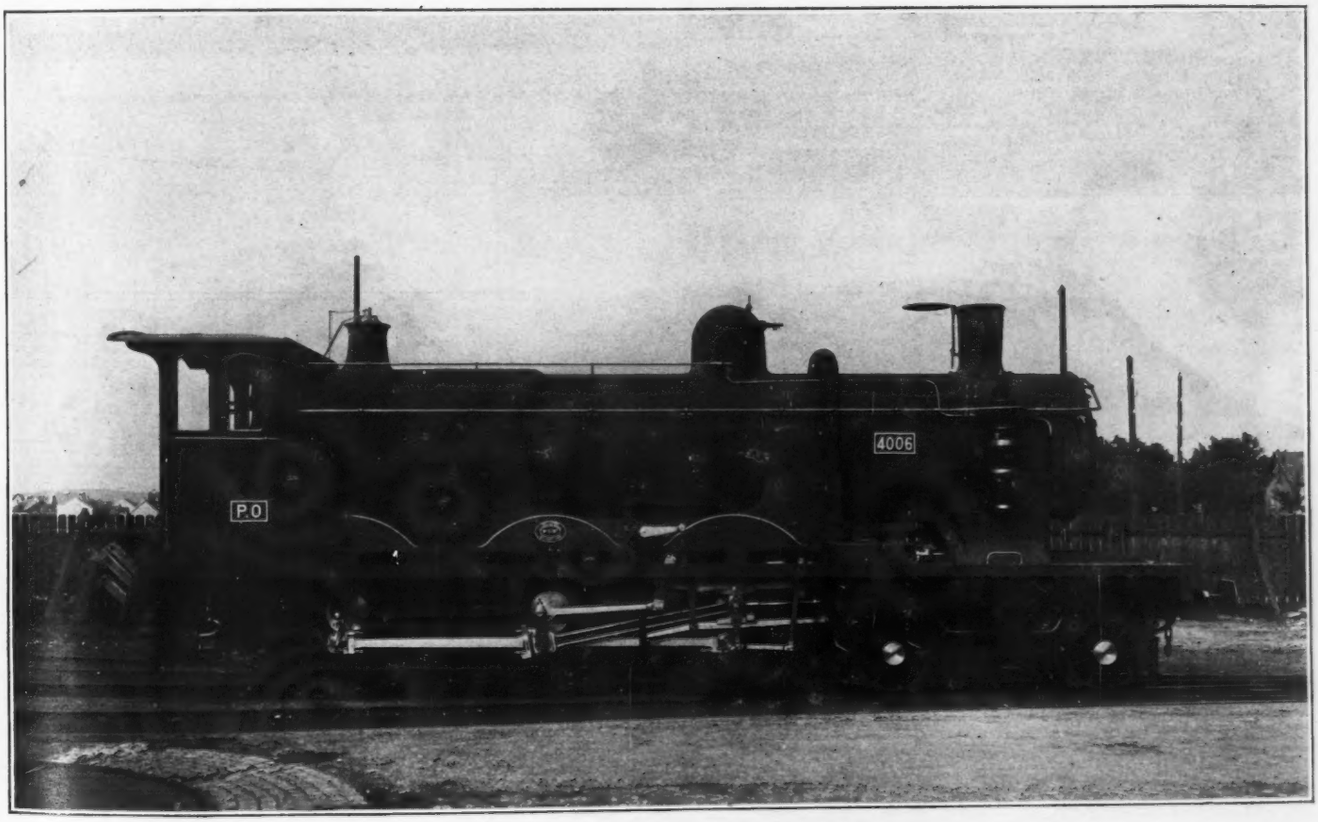


FIGURE 67. EXAMPLE OF FOREIGN LOCOMOTIVE FROM BELFORT WORKS.

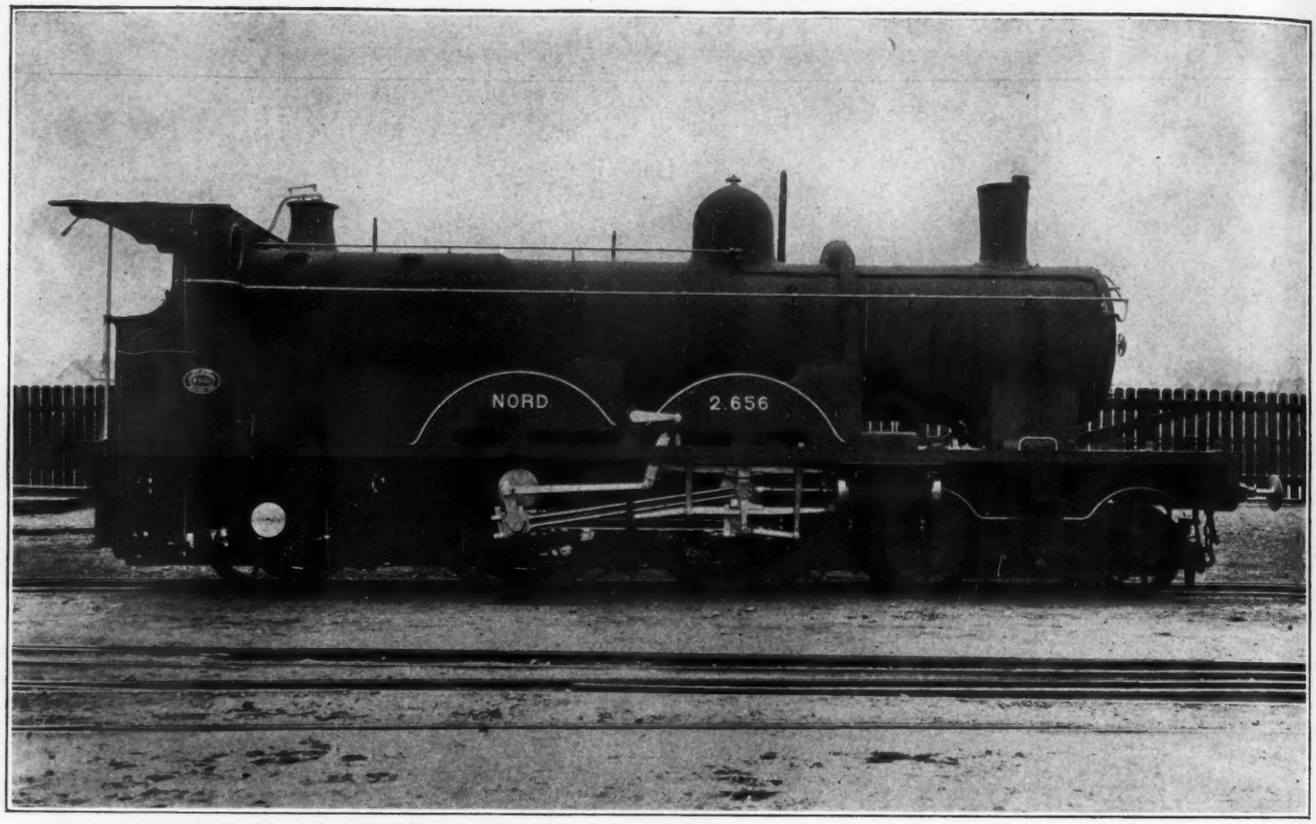


FIGURE 68. EXAMPLE OF FOREIGN LOCOMOTIVE FROM BELFORT WORKS

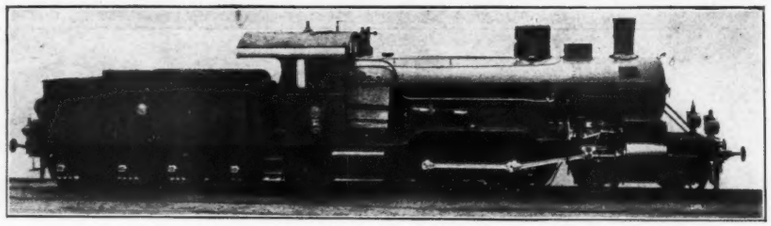


FIGURE 69. FOUR-CYLINDER BALANCED COMPOUND, VAN BORRIES SYSTEM, ATLANTIC-PRUSSIAN STATE RAILWAY, HANOVER, 1904

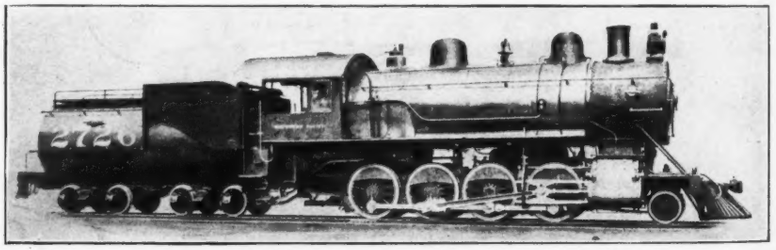


FIGURE 70. SIMPLE CONSOLIDATION, S. P., BALDWIN, 1904

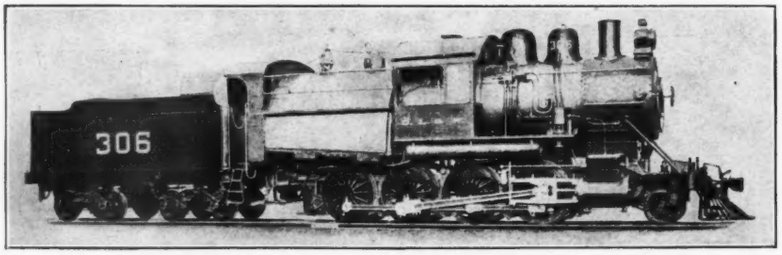


FIGURE 71. SIMPLE CONSOLIDATION, D, L, & W." BALDWIN, 1904

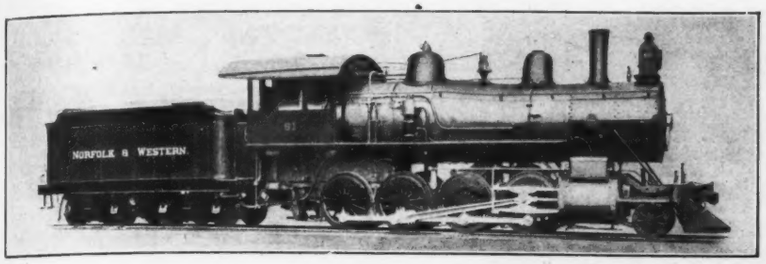


FIGURE 72. TWO-CYLINDER COMPOUND CONSOLIDATION, N. & W., BALDWIN, 1904

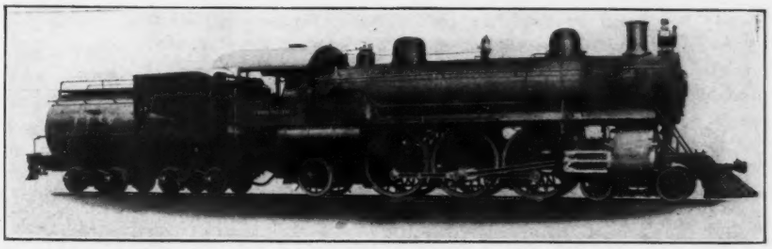


FIGURE 73. SIMPLE PACIFIC, U. P., BALDWIN, 1904

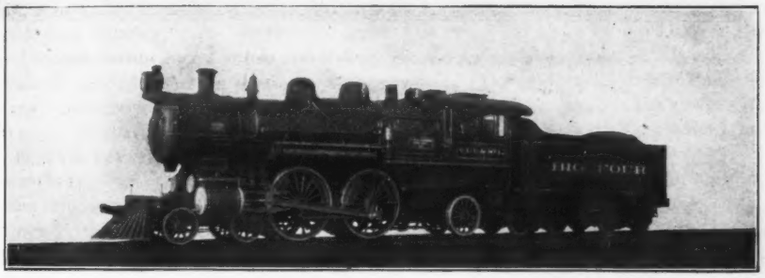


FIGURE 74. SIMPLE ATLANTIC, BIG FOUR, AMERICAN LOCOMOTIVE COMPANY, 1904

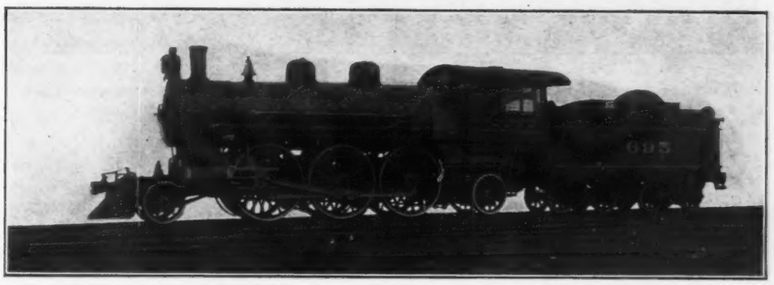


FIGURE 75. SIMPLE PRAIRIE PASSENGER, L. S. & M. S., AMERICAN LOCOMOTIVE COMPANY, 1904

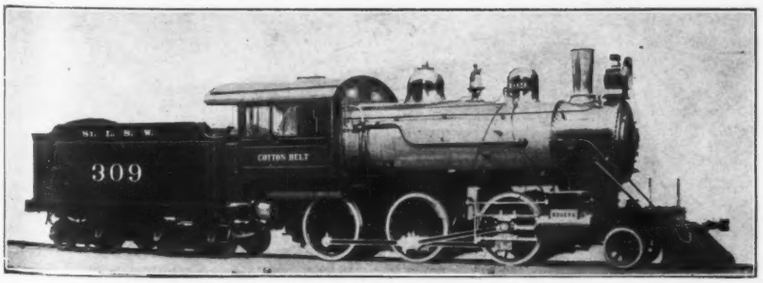


FIGURE 76. SIMPLE MOGUL, ST. L. & S. W., ROGERS, 1904

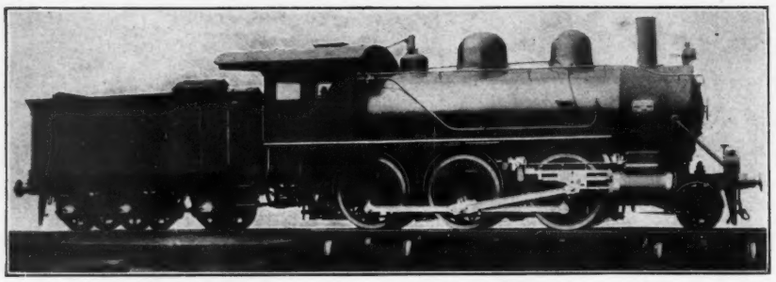


FIGURE 77. SIMPLE NARROW-GAUGE MOGUL-JAPAN, AMERICAN LOCOMOTIVE COMPANY, 1904

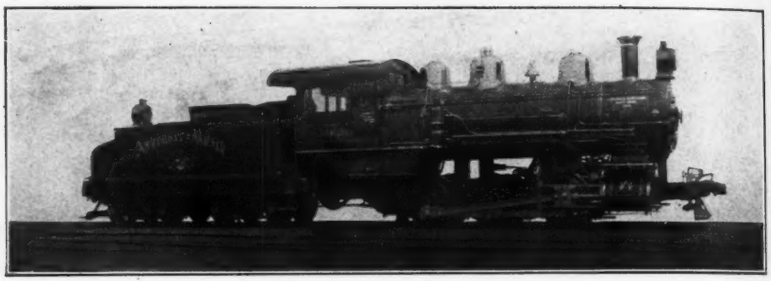


FIGURE 78. SIX-WHEEL SWITCHING LOCOMOTIVE, MFGR'S RY., AMERICAN LOCOMOTIVE COMPANY, 1904

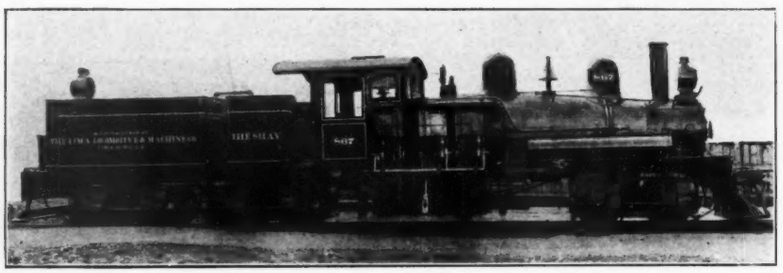


FIGURE 79. SHAY GEARED LOCOMOTIVE, LIMA LOCOMOTIVE AND MACHINE COMPANY, 1904

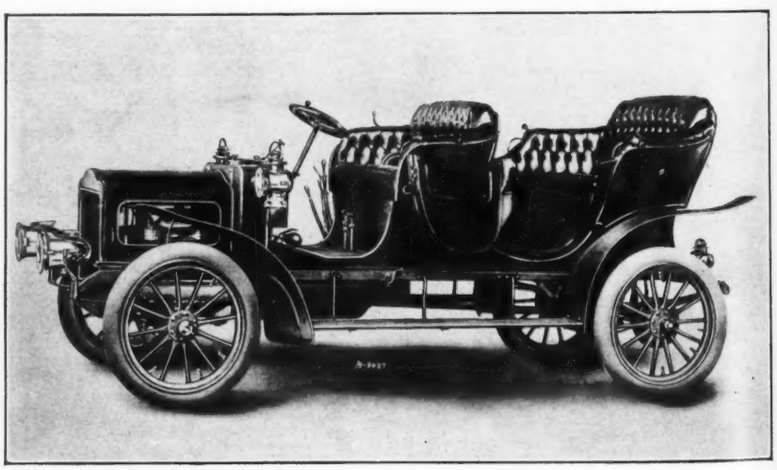


FIGURE 80. WHITE AUTOMOBILE, 1906 MODEL

TECHNICAL EDUCATION OF THE TWENTIETH CENTURY.*

THE foundation of a technical training consists of nature's laws and phenomena, and as nature's laws are fixed and inexorable, a student possessed of a knowledge of what has been, knows what will be, and it is this that forms the ground-work of the twentieth century system of education. But this is not all; it should go further; it should elevate the new generation to a higher plane than mere investigation; it should cultivate powers, a higher ideal and a struggle for genius, the divine, the creative.

An education implies first, a student or scholar to be educated, second, a process or method by which the education is to be acquired, and third, an ulterior purpose or ultimate utilization of the education to some good aim and end.

When the high school or seminary training is finished, several questions present themselves to a young person, among which are three, viz: (1) What shall I do or become? (2) Shall I attend school or become an apprentice? (3) Shall I enter the general or technical courses of instruction? The first question must be answered by the tastes, qualifications and opportunities possessed by the person. The second question is usually determined by the pecuniary limitation of the person. The third question depends upon the advantages to be secured or benefits to be derived, and is a subject for discussion under our topic.

It is not a new subject, but there may be some new things in it, in the light of another's experience. I am not an advocate of an extended general course in college as a condition precedent to technical training.

I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self-reliance which the twentieth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends he must gain his experience and acquire a cliental. His married life is postponed and his ideal life shortened by a decade.

In the earlier days of education, theories and laws were assumed by one school, and controverted by others. Fortunately, all this has been changed and modern methods of education are those where observation is cultivated and the reasoning faculties directed to explain the phenomena observed. This is the process of imparting information by directing the student in paths richly bordered with the fruits of wisdom.

The difficulties are removed. The student, though in quest of exercise, has had everything done to lessen the labor. Those obstacles that give to the forest trail its glories, or to the mountain stream its power, have been removed and the Venetian canal has been substituted.

What is the result? It is that all students have been to Venice; all have observed and been taught the same things. The original trend or natural taste of the child or youth has been limited to the banks of your canal. Your graduates are all alike. Genius has been dwarfed and freedom enslaved.

We need to cultivate heroes whose spirits no conventionalities could restrain and who overcame and turned the tide of the world's ignorance, prejudice and jealousies to the light and the truth. They are originators. They have visions unlike the average man.

These limitations in education do not differ solely with the period, but they are greatly affected by the conditions and localities. They are less marked in the smaller and outlying schools than of those in our great communities.

In cities and our great universities located therein, the people forget that the sky overhead is not adamant or lignum. Their chief sources of knowledge are books. Much profitable learning comes from primitive life and from the discomforts of human existence. A millenium of human comfort and conveniences is not healthful to intellectual progress nor to physical development.

It is notorious that the strong men and women, those who possess mental and physical superiority, in our schools, in business and in our industrial and professional occupations, are largely from the country.

In the general courses the studies that you pursue are determined, in the larger universities, by the students' own election. The tendency is toward this plan. By it the student may take his collegiate course and at the same time pursue courses required in the professional classes. This will lead to the three years' collegiate courses and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect his profession or business, and to take subjects prescribed or acknowledge to be advantageous in the vocation adopted, then it is, to my mind, most desirable. If the student be permitted to follow his own inclinations, which in four cases out of five will be those avenues of least effort, than the system is detrimental. The student may know less at graduation than at entrance. If he elect the elementary subjects in the various departments, acquire what is popularly known as general culture, and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

There is the choice of school to consider, the large and the small, those in cities and those in country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at a time. The various systems have many advocates. Each maintains that its system is *the* system. There is the choice between the elective and the prescribed courses of study, the experimental and the theoretical systems of teaching sciences.

In my opinion, it is those institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses for lower classmen and leave the election to upper classmen, that truly derive the benefits of both systems.

Cultivate exquisite care and practice heroic effort. As our country grows older and competition becomes greater, the requirements of an education increase. Students who expect and hope to excel in the competition that prevails in our great cities must have something better or something different from that possessed by others.

Refinement should be applied to all that you do and undertake. Your mental training should be refined on the same plan. Put an equisite finish upon your work. That is what makes the artist; it is what distinguishes the actor and soldier from the business man or laborer, and it is what makes the successful technical engineer in the present day.

Technical training as offered by our industrial schools tends to develop abnormally particular lines of the intellect and greatly enlarges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of the five senses. Yet the world has need of such men. He may not be wanted frequently, but occasionally his services are required when they command great prices.

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree as the final goal of his educational ambitions. Few study or expect to study after graduation, except perhaps in short crams for a civil service or professional examination.

Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward, and at a rate that will appall you when you come into competition with some recent graduate fresh from his studies.

*Abstract of Founder's Day Address, November 30, 1905, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., delivered by John assan Wait, M. C. E. (Cornell), LL. B. (Harvard.)

A far-seeing man will, before spending very much time or money for a thing, inquire what specific uses he will make of it, and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and sciences by his declaration that he doesn't like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work, it is a grave misfortune for one to school himself or herself in a business in which they have not a real liking and to which they cannot bring enthusiasm. Elect something to your liking and something in which there are opportunities and for which there is a demand.

The utilization of technical training in the industrial pursuits and development is everywhere apparent in this country. To no other one element are the country and the people more indebted for their wealth and prosperity. The physical comforts of home, of business and of travel are due to the marvellous provision of the technician.

The economic value of this training is illustrated by the trade, domestic as well as foreign. No country can have claims to world power until it developes the industrial talents of their people and the natural resources of the land. The balance of power remains where the scientific, industrial and mechanical arts are best treated.

Education of this century should not be confined to book learning nor to the study of mathematical and physical laws. Some time should be given to economics and sociology. Methods and means of conserving and protecting what is acquired are quite as important as are the ways, methods and means of acquiring. Close upon the footsteps of progress in its march is trade, with its competition and its protector, economy. The wasteful methods of the pioneer can not survive the rivalry of commerce. Economy in the production and utilization of materials or power is what effects great savings, and it is the man who can effect great savings who can command a salary commensurate with his savings.

But the twentieth century education should not only cultivate the courage and capacity of a man or woman to cope with nature, but should also give some insight into the laws, institutions and systems of society. It frequently takes some people the best years of their life to become acquainted with themselves and to discover what they really are to the world. Some men take years to overcome the natural diffidence and timidity that possess them, which might be corrected in youth by proper surroundings and by a kindly interest of their teachers.

A discussion of technical education in this country should not omit some reflection upon the social inequalities that are certain to exist. We may look back upon a century mighty in its achievements, gigantic in its forward stride, matchless in its intellectual expansion, industry and invention, in its manifoldness and vastness of its enterprises, the grandest of all the centuries in history. The heavy burden of labor has been taken from the shoulders of men, and the workman has been made the equal of his neighbor. He has better food, raiment and shelter and better remuneration for his time.

The technical schools should aim to turn out men who can undertake the instruction and improvement of this class of people. Trade schools should be erected and instruction offered in the useful arts. They control the great avenues of commerce, the necessities of life, food, fuel and raiment, Never was there the necessity for the unity of men and the realization of the dependence of the polite upon the industrial.

The education of the twentieth century will, I predict, enlighten every continent on the globe. What has been begun in the past century will lead to greater and more lasting results in this century. The twentieth century should lead the human race to heights which shall strengthen the faltering steps of art, philosophy and religion.

What the twentieth century demands, is the cultivation of originality and the development of the creative genius of students. Creation should be the highest aim of every student. A small thing created may be truly greater than a large thing borrowed, and the original thought or design of vastly greater import than any imitation. The present century requires the development of geniuses and especially in the technical fields. Old and trodden fields must be departed from and new, though rough, trails taken. New practices and methods must be devised and these are more likely to be discovered by departure from, than by following in the channels hewn by our predecessors.

The twentieth century education should embody artistic treatment in structural work and in mechanical contrivance,—a relaxation from the intensely practical and economical to a study of what is pleasing and what is beautiful. Some have an idea that there is not much that is beautiful in the mechanical and industrial. Nothing is further from the truth.

It is for the twentieth century education to impart the beautiful and artistic to the useful, to lend inspiration and give expression to the deeper feelings of industrial life, its burdens, its struggels, its rewards and its glorious victories. The twentieth century should make its technically educated men something more than the mere directors of processes. Men and women should be taught to vary their employment and to seek recreation in the profitable exercise of their intellectual faculties. The spirit of man needs more than gain, more than crowning success of its efforts, more than the applause of fellow men; it needs the hope and cheer of the life everlasting.

ANNUAL MEETING AND DINNER.

THE annual meeting and dinner of the Electrical Trades Association of the Pacific Coast was held at Techau Tavern, San Francisco, Saturday night, January 27, 1906.

This association is a co-operative association, composed of the principal dealers in electrical goods on the Pacific Coast, who are grouped together for the interchange of trade information, and for protection in the matter of giving credit to purchasers.

The Electrical Trades Association is a part of the National Trades Association, composed of associations as follows:

New England Electrical Trades Association, Electrical Trades Association of Philadelphia, Electrical Trades Association of New York, Electrical Trades Association of Chicago, Electrical Trades Association of Canada.

It is the custom of the association to hold its annual meeting for the election of officers during January of each year, and after the business meeting a dinner is given the members and guests.

The annual election of officers was held and officers elected as follows:

C. C. Hillis, of the Electric Appliance Company, president; Samuel H. Taylor, of the Electrical Railway and Manufacturers Supply Company, vice-president; J. Bray, of the California Electrical Works, C. Hillhouse, of the John M. Klein Electrical Company and John R. Cole were elected as the three members of the executive committee, who, together with the president and vice-president, are to manage the affairs of the association for the ensuing year.

The secretary-treasurer of the association, is Albert H. Elliot, who is appointed by the executive committee, with offices at 905-06 Call Building.

After the business meeting the dinner was held, with John R. Cole acting as toast-master. Speeches were made and stories told, and other electrical effects produced.

Delegates representing members came from Portland, Seattle and Los Angeles, and it is the custom each year for houses to send delegates to the annual meeting.

STEAM TURBINES.

Journal of Electricity, Power and Gas, Rialto Building, San Francisco:

DEAR SIR—The writer noticed an article in your January issue on the steam turbine in which the following statement occurred.

"The question of durability and economy in steam turbines is without doubt the most important to the practical man. It has been claimed, and perhaps rightly that very little data has been forthcoming as to the wear of buckets, etc., and the resultant depreciation of steam economy. The fact that steam turbines have only been in operation for such a comparatively short time is probably the cause for the supposed holding up of the information."

This is without doubt the most important feature to the practical man, as economy shop tests are of little value unless that economy can be maintained during continuous operation without seriously impairing the safety of the machine.

The question of the wearing of blades is also one which should be seriously considered by an intending purchaser of steam turbines, as theoretical considerations would lead one to expect that the wear would be excessive, being different however with the different types, depending upon the relative speed of steam and blades. We await with interest any data which may be published on this point.

Regarding the matter of maintaining the guaranteed economy during everyday operation, the writer believes the following which appeared some time ago in an eastern technical journal will be of interest.

"An interesting discussion has been in progress in our English contemporary, *The Electrical Engineer*, in regard to the comparative efficiency of steam turbines and reciprocating engines for use in electrical generating stations.

"In the number of December 25th, Alfred Morcom, managing director of Beliss & Morcom, Ltd., contributes a very interesting letter, in which he says, among other things, that coal and works cost for steam turbines is .78 and 1.6 as compared with .738 and 1.4 for reciprocating engines. The former figures are gathered from an average of eight exclusively steam turbine stations and the latter from data collected from 160 reciprocating engine stations. The steam turbine stations are all there are running at present. He says: 'Instead of the steam turbines being as claimed, as good as the best reciprocating engines, the figures for the turbine stations are not even up to the average of the good and bad of all sorts. These figures, will, we think, appeal to an open-minded reader, as many of the 160 engine stations have old type and uneconomical plant of various kinds.'

"After discussing the effect of and the difficulty of securing high vacuum which add so much to the steam turbine economy, he sums up the situation as follows:

"1. For more than twenty years it has had the continuous attention of some of the best and most ingenious mechanical engineers, in this country or elsewhere, but up to date the chief difficulty—viz: that in connection with the clearance—has not been solved, and is probable incapable of practical solution.

"2. The amount of the clearance permitted to obtain the results published is so small, that grave practical difficulties are produced by expansion under the temperature of the working steam. Certainly this clearance can never get less during the working period, and we assert that the published figures show that it increases.

"3. To enable results to be obtained approaching those we can get from triple-expansion reciprocating engines, superheat of a considerable amount must be employed, and the clearance must be proportionately increased. It is impossible under the working conditions in a station to keep the superheat within any but very wide limits, and as the clearance must be made large enough to meet the maximum superheat, waste of steam through the clearance at working temperature must be largely increased.

"4. Stripping of blades may be caused by the superheat overheating them or over-expanding the rotating part as a whole, and it may also be brought about by water or a very small foreign substance at this very high peripheral speed.

"5. The improvement in economy in the steam turbine is limited by this question of practical clearance, and there does not appear to be much chance for further improvement in view of the great care and thought which has already been expended.

"6. The one big point in connection with a steam-turbine plant that appeals to everybody is the fact that the larger sizes especially can be manufactured much more cheaply than the same power of reciprocating plant, but against this must be taken into account the fact that with the steam turbines go boilers and condensing plant much larger than in the case of the reciprocating-engine. Any big differences in economy or unreliability of the plant would make the difference in first cost a trival matter compared with the trouble which might result from the change."

Yours very truly,

SUBSCRIBER.

FUTURE OF DIRECT CURRENT TRACTION.*

THE controversy as to the relative merits of direct and alternating current traction, particularly with references to steam railroads, shows no signs of abating. It was aroused by the fact that two great railroad systems which enter the same New York terminus, and use the same suburban and terminal tracks for a distance of several miles, are employing two different types of motor, one direct current and the other single-phase alternating current. The controversy is wider than that of merely the two railroads concerned, for it includes the two largest electrical manufacturing concerns in the world; one the General Electric Company, which is furnishing the direct current equipment, both for power stations, lines, and rolling stock; and the other the Westinghouse Company, which is furnishing the single-phase alternating equipment for the New Haven lines from Stamford to their junction with the New York Central system at Woodlawn. The alternating current advocates have expressed surprise that such an important installation as that of the New York Central terminal lines should have been equipped with the direct current, arguing that it is approaching the stage at which it will not compare in economy, particularly for long-distance work, with the more convenient and flexible alternating current.

It is stoutly maintained by the direct current advocates, that it has by no means reached its final stage of development, as proved by the fact that recently tests and results of 1500-volt direct current railway motors have become available, and that there are rumors of a 700-mile direct current transmission. It is urged that 500 to 600 volts is merely a stepping stone to more efficient pressures, which are sure to be used. A correspondent of one of the contemporary journals devoted to street railways, claims that it is now practically possible to furnish reliable direct current railway apparatus for a voltage of from 1000 to 1200 pressure; and that with proper designing of the magnetic circuit in the motors, and the placing and insulation of the controlling apparatus, there is no reason why the advantages of high voltage should not be realized under the direct current system, as they now are in the alternating system.

GAS ENGINE INDUSTRY IN GREAT BRITAIN.

The *Mechanical World* recently contained an epitome of a lecture by A. B. Roxburgh, of the National Gas Engine Company, Ltd., in which it was stated that about one-fourth of all the gas made in Great Britain is employed in driving gas engines. The lecturer estimated that in the United Kingdom alone there are manufactured at least 200 gas engines per week. Averaging them at the very low size of ten brake horespower each would give a weekly production of 2000 brake horsepower. It was deemed likely, however, that the actual amount is double that figure.

*From *Scientific American* January 13, 1906.

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EDITORIAL.

QUESTION OF ELECTRICAL CONDITIONS.

Electricity means the salvation of this State as far as the matter of transportation is concerned. Up to the present time the great difficulty that California has had to contend with is the dearness of transportation. This is owing to the absence of fuel in large quantities. In fact, the railroads on this coast have to spend twice, if not more than three times, as much for fuel as do the lines in the East. The problem of cheap transportation only will be solved by the introductfon into this State of electric cars. Within the past few months there has been given to this enterprise an enormous impetus, and there is hardly an issue of the daily papers that does not give some account of some new railroad being incorporated which will use electricity as its motive power.

The electric road has been a formidable competitor of the steam road in Pennsylvania and has to a certain extent absorbed the local travel. Their lines parallel the steam lines and their service is preferred, owing to the cleanliness of the electric cars.

We have no need to go so far afield as Pennsylvania for instances as to the way the competition of the electric car works as against the steam car. H. E. Huntington has in no indisputable manner solved this question. He has put into operation a very complete electric car system, and the success of his lines was so marked from the beginning that it compelled E. H. Harriman to make a deal, so that he get a share of the profits that were accruing to Huntington from his electric car system.

When the electric cars first began to run to Santa Monica the Southern Pacific officials in the south jeered at the idea that the line could come in competition with their system. They did not jeer for long. The electric cars did all the work, and the Southern Pacific cars were empty while there was no standing room on the electric cars. In order to meet this competition the Southern Pacific cut down its rate, and even with the rates on a parity the public preferred the electric car.

What has been done in the southern part of the State in the way of electrical transportation will be duplicated in this part of the State. We have every reason to believe that we are entering on an era of electric railroad building. That these roads are a success leaves no ground for argument. This has already been proved by the North Shore. The North Shore is one of the finest railroad properties in the State, and its success as a money-maker is entirely due to the fact that the local trains to San Rafael are run by electricity. There is no train which will be so great a favorite as the electric one to the suburbanite. It is fast and, above all, it is cleanly. When a line is managed according to business principles it will be a good investment, but if "run after a fashion," then it is bound to run behind.

The electric road is destined to make one city from here to San Jose. We are informed through the medium o the papers that it is contemplated to run more than one line from here to the Garden City.

Then there is the Ocean Shore line, which is fathered by J. Downey Harvey, and which promises to bring about a great change in property that has hitherto been thought only good for cow ranchos. Already land about Half Moon Bay has been sold to an enterprising syndicate of real estate men and it is their intention to boom this land for residential purposes.

We all know what is being done in the northern counties. Electric lines are paralleling the California and Northwestern and we are informed that it is the intention of the promoters to have an electric road tapping all the rich northern portion of Mendocino County.

H. E. Huntington has been credited with even a bolder scheme. That is to connect the cities of San Francisco and Los Angeles by an electric road. This much is certain. Mr. Huntington has been taking up all the water power in the Sierras, and he has had many men out in the mountains for this purpose. He has had some reason for this expenditure beyond that of merely grabbing all the power in the country.

As was said in the commencement of this article, cheap transportation means the salvation of this country. There are vast tracts of fertile land in this State which are unused to the plow simply because of the difficulties that the farmer has to meet with in order to get his produce to market. If the Southern Pacific had taken up this matter of cheap transportation some years ago they would have been in better condition to fight the Western Pacific than they are today.

It will be remembered that each franchise which has been asked for by the Western Pacific has had the clause, either steam or electricity. If the Western Pacific intends to gridiron the State with a number of cheap roads, that means money to the Western Pacific, and judging

from the hints that have been dropped by the officials of the Gould roads that is their intention.

In the East the electric road has been an upbuilder of not only suburban property, but of farming communities.

It is the small farmer which is urgently needed in California. It is true that the Southern Pacific has been instrumental in bringing to this coast a very large number of families who have the making of good Californians. But these people are at the outset confronted with the matter of transportation, and when they realize that there is no cheap transportation in the State they are appalled. What is the secret of these people going to the south and not settling here? Simply this: In the south electric cars run everywhere and more lines are being built, and the problem of transportation is simplified. When the north gets as good railroad facilities as the south then we will be able to compete with the orange belt on even terms.

EDUCATION AT OUR DOOR.

Never in the world's history has the training of the young received the attention it is receiving today. The tribute of public and private wealth is paid to modern civilization to secure the best in education. In the care and culture of the rising generation largely rest the future stability and safety of the State; therefore the wisdom of the age is enlisted in the solution of educational problems, problems physical and moral as well as mental. This is an intensely practical age and public and private institutions are vying with each other in trying to provide courses of training to meet the demands of the strenuous era. Private enterprise, on account of its inherent ability for quick action, is frequently in advance of public institutions which have to wait for a concensus of judgment.

Among the private schools of the country none is better or more favorably known than Heald's. The name is familiar in nearly every household on the Pacific Coast. It was primarily a commercial training school, and thousands of prominent business men of the Pacific Coast acknowledge the start in life they received from this institution. A few years ago Edward P. Heald, the president and founder, recognizing the demand and the opportunity, organized the Heald School of Mines and Engineering. The different departments were for a time conducted in the main college building on Post Street, alongside of the other departments. The growth of all departments finally demanded larger space, so about two years ago the Engineering School was installed in a new brick building at 130 Union Square Avenue, to which we recently made a visit. We were greatly pleased and surprised at the equipment of the school, and left with the conviction that San Francisco contained one of the best engineering schools in the country.

Mr. J. H. White, formerly with the Pacific States Telephone Company, and recently with the Electrical Equipment Company, is now associated with A. D. Keeler & Co., 90 Second Street, San Francisco.

PERSONAL.

Mr. F. E. Corwin, of the Dunhan Carrigan and Hayden Company, has gone East as the representative of the electrical jobbers on the Coast.

Mr. A. Eugene Michel has recently entered the employ of the Geo. H. Gibson Company, advertising engineers, Park Row Building, New York City.

Mr. Kendall Banning, formerly managing editor of "System" has purchased Mr. Johnson's interest in the firm of Bruce & Johnson, 42 Broadway, New York.

Messrs. F. H. Murray and R. M. Murray have opened a warehouse at 679 Howard Street, San Francisco, where they will carry a full line of National Carbon Company's goods. Both of the Messrs. Murray were formerly employed by the National Carbon Company, of Cleveland, O., and have, therefore, a full knowledge of the company's stock and their trade's requirements.

Mr. Henry C. Ebert, assistant to the third vice-president of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., has resigned his position to become the president of the Cincinnati Car Company and vice-president of the Ohio Traction Company. Mr. Ebert's connection with the Westinghouse Electric and Manufacturing Company dates back about fifteen years.

Mr. H. R. Noack, of the firm of Pierson, Roeding and Company, San Francisco, has just returned from an extended trip throughout the East. While visiting the principles of the various companies they represent he found every concern working overtime and the only question was can we fill our western orders. This speaks well for the rapid development of the West. Mr. Noack remained a few days in Los Angeles on his return and established their southern offices.

Mr. E. F. Cannon, president of the E. F. Cannon Company, has sufficiently recovered from his late illness so that he will be able to depart for the Hawaiian Islands. Mr. Cannon will sail from San Francisco February 6th on the steamer Mongolia, for Honolulu, to be absent three or four months. The after effects of a severe attack of pyemia blood poison, which Mr. Cannon passed through in 1900, left his constitution in a shattered condition, from which he has never fully recovered. Mr. Cannon has decided to spend the winter months in search of health.

Mr. Harry Y. Haden, who has been making an extended trip throughout the West in the interest of the De Laval Steam Turbine Company, of Trenton, New Jersey, has just reached San Francisco, where he will remain for several weeks. Mr. Haden will devote his attention to the possibilities of steam turbine units on the Pacific Coast, and will incidently deliver one or two lectures before technical societies on this subject. The Joshua Hendy Machine Works are agents for the De Laval steam turbine in California and the Kilbourne & Clark Company for the Northwest.

BOOK REVIEW.

The Cement Age—The December number of this magazine contains some valuable and readable articles on the uses of cement. The publication is edited by Robert W. Lesley and published by Bruce & Johnson of 42 Broadway N. Y.

Annual Catalogue—The thirty-sixth annual catalogue of the Worcester Polytechnic Institute is to hand. This booklet gives an interesting account of the work done during the past year and also in a succinct way outlines the history of the admirable institute.

Interesting to Merchants—Herbert W. Furlong, assistant secretary of the Pacific Commercial Museum, has published an exceedingly interesting brochure upon the museum, showing its growth and the value of the organization to the Coast. It is well worth a careful perusal by the merchants of this city.

Scientific American—In its issue of January 13, 1906, has published a special Automobile number, the outer cover being a work of art in colors, its contents covering every known type of automobiles, and some very interesting cross continent reviews profusely illustrated. Munn & Co., 361 Broadway, New York.

Valuable Journal—The engineering department of Cornell University publishes an admirable magazine under the title of "The Sibley Journal of Engineering." The papers are well written and timely, showing good judgement and complete mastery of the subjects that are discussed. One of the best of the papers is that entitled "Over Crowding in Technical Schools," by D. S. Kimball. It will appeal to everybody.

Modern Turbine Practice and Water Power Plants—By John Wolf Thurso. D. Van Nostrand & Co., New York. 244 pages; illustrated; price $4.00. A book containing excellent descriptions of different types of European and American turbines, giving several good chapters on the design of water power plants, in connection with which the author has had an extended experience. The portion treating of impulse wheels is very meagre. The chapter on steam turbines is too brief to do more than treat the subject in a very superficial way and adds little to the value of the book.

Worthy of Endorsement—The educational number "For California," which is by the California Promotion Committee, gives a concise statemement of the educational situation in the State. Of special interest owing to the fact that the National Educational Association will hold its convention in San Francisco in July, is the article by Nathan Schaeffer, president of the association, which tells of the organization and its work. President David Starr Jordan, of the Leland Stanford Junior University, tells of the intellectual growth of the State, while other writers of equal importance discuss different systems and conditions.

For the Public—The General Electric Company has issued supply Catalogue 7594 in which much valuable information is contained.

Reliance Corliss Engines—The Allis-Chalmers Company has issued Bulletin No. 1501 which describes the Reliance Corliss Engines. The pamphlet is well illustrated.

Switchboard Panels—The General Electric Company has in its bulletin 4425 given an elaborate description of 1150 and 2300 alternating current switchboard panels which will be useful to those interested in this subject.

Water Wheels—The Abner Doble Company has published a most interesting phamphlet on the Doble Tangential Water Wheels in which full information can be obtained of these highly useful wheels. The book is well illustrated and deserves attention.

Electric Hoisting Machinery—The Crocker-Wheeler Company in its Bulletin 62 gives interesting data regarding electric motors for operating all classes of hoisting machinery. Contractors will find the electric motor especially valuable and their attention is drawn to this bulletin.

Bulletin No. 200, illustrating and listing exchange and subscribers' supplies, line material and tools, has just been issued by the California Electrical Works. The catalogue contains ninety-one pages and is very comprehensive. It will be mailed free, to telephone exchanges, upon request.

The Buckeye Electric Company of Cleveland,—Have issued an unique advertisement in the form of a folder which gives a picturesque view of the city of Babylon and also some good reading matter. Not until the end of the paragraphs are reached does one discover that it is an "ad" for the Buckeye Company.

Incandescent Lamp—The General Electric Company, of Harrison, N. J., has published a number of bulletins all of which go to show the incontestable superiority of the incandescent lamp for stereopticons, magic lanterns, projecting and headlights. In economy and general adaptability the lamp is without its superior.

The Benevolent Giant—"The Colburn Trolley Track is a giant" is the statement made by its makers, and it goes further and says that with its lifting appliances it gives one man the strength of ten. The Colburn Trolley Track Manufacturing Company advertises the fact the Colburn way requires one-fifth the labor at about one quarter the expense.

Reliance Friction Clutch—The Allis-Chalmers Company in their Bulletin No 1202 has a description of the Reliance Friction Clutch which has been designed for the heaviest work, with particular regard to simplicity, durability and ease of adjustment. This clutch is claimed to be the superior of any other friction clutch on the market.

Printing Press Motors—The Stanley G. I. Electric Manufacturing Company in their Bulletin No. 42 advocates the use of operating printing presses by electric motors. It gives a variety of reasons. In the first place the cost is low, speed can be absolutely controlled, line shafting is eliminated and there is also an absence of objectionable noises.

Laths, Mills and Bolters—The Allis-Cnalmers Company in its bulletin 1704 describes a four-saw lath mill with improved press and feed rollers which will recommend itself to the trade. This is a strong and well built machine with steel arbor, adjustable guide for sawing pickets, and for live feed rolls, two in front and two at the back of the saws.

Maydole Hammers—The David Maydole Hammer Company, of Norwick, Chenango County, New York, have issued an exceedingly interesting pamphlet on the Maydole Hammers, which are press-forged from solid crucible cast steel. The works of this company have been greatly enlarged and many new numbers to the variety of hammers have been listed.

Colored Glazes for Insulators—The Locke Insulator Company in its Engineering Sheet No. 3 has an ingenerous solution for the protection of insulators which are so liable to injury. It proposes to produce an insulator the color of which will blend not only with the galvanizing but with sky and foliage. A good tint for general use is D. 100. All the colors are obtained with hard fire porcelain glazes.

Bullock Oil Insulated Transformers—The Allis-Chalmers Company in their Bulletin No. 1047 give a description of transformers which are for indoor use and are made in two types according to the method of cooling. Both are oil filled. In the oil filled self cooled type the heat is carried off by radiation from the case, while in the oil filled water cooled type water circulation is used to insure cool running.

Bullock Generators—The Allis-Chalmers Company has issued bulletin 1048 in which is given a description of the Bullock generator which will be eminently good reading for those who are interested in this class of machinery. According to the bulletin the Bullock alternators are of modern design and are made for all classes of service. Those herein described are intended for direct connection to steam engines, but complete lines of machines for belt drive and for direct connection to water wheels and steam turbines are also manufactured.

Electro-Static Voltmeters—The Westinghouse Electric and Manufacturing Company has an electro-static voltmeter which is said to be one of the finest instruments made for high pressure measurements and it claims to have a meter that is free from the effects of variation of wave-form, and is direct reading. It also claims that the fault inherent in all other methods of high potential measurement are entirely absent from this meter.

Artificial Lights—According to Bulletin No. 4431 issued by the General Electric Company great advances have been made in recent years in the way of electric lighting, and with the invention of the Concentric Diffuser and the Light Balancing Selective Diffuser Ceiling, the light has attained a quality, steadiness and diffusion hitherto unappreciated. It is particularly well adapted to millinery and florist stores and also to railway stations and tennis courts.

Watch Case Instruments—The Stanley G. I. Electric Manufacturing Company in Bulletin No. 20 gives an interesting description of watch case instruments, voltmeters and ammeters. These instruments are most convenient for testing small primary or storage batteries used for telephones, bells or the ignition circuits of small gasoline motor cars. They are equally useful for physicians batteries, or for testing single cells of large storage battery installations.

Westinghouse Industries—The Westinghouse Companies have issued a remarkable interesting brochure in which is given a complete history of their various enterprises in the industrial world. This pamphlet, which is well illustrated. is called "The Westinghouse Companies in the Railway and Industrial Field." It consists of sixty-seven pages and is accompanied by a map of Pittsburg showing the location of the Westinghouse interests reached by steam and trolley lines.

Tremain Steam Stamp—The Allis-Chalmers Company in its Bulletin 1408 gives an entertaining description of the Tremain steam stamp which it declares has been designed especially to meet the demands of those who own mining properties in the first stages of development, enabling them to establish a thoroughly good crushing, amalgamating, or concentrating plant of moderate capacity, in the shortest possible time, with the least material, and for the least money.

Pipe Thawing Apparatus—The Westinghouse Electric and Manufacturing Company has in their Folder No. 4051 an interesting account of thawing frozen water pipes by means of electricity. It goes on to say that for the past few years practical demonstrations have been made which have proved that this is a reliable and an economical method for thawing frozen water in pipes. It has grown in great favor with the general public and there is a great demand for a light weight equipment which is moderate in cost.

The Paragon Sewing Machine Transmitter represents the highest development in the art of operating sewing machines by means of electric motors or as they are generally known, "Sewing Machine Transmitters." The drive between the sewing machine and the transmitter is positive, with a speed variation ranging from a few stitches per minute to the maximum. The device is absolute and must not be confused with apparatus in which speed variation is obtained by means of a slipping belt or rheostatic control. It is manufactured by the Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass.

Belt Driven Generators—The General Electric Company in its bulletin 4426 gives the following description of the CL-B (type CL form B) multipolar generators are built in capacities from sixteen kilowatts to 150 kilowatts at various speeds and voltages, and represent the latest developments in the construction of small slow and moderate speed direct current belted generators. They embody improvements which have suggested themselves after long experience in the design of apparatus of widely varying mechanical and electrical characteristics. In the design of the generators every effort has been made to make all parts simple, and to make the machines as a whole compact and at the same time thoroughly accessible for inspection and repairs.

Type M C Governor—In its Bulletin 4427 the General Electric Company observes. The independent motor-driven air compressor, now so extensively used in connection with both the brake system of the modern electric car and stationary compressing plants, requires for successful operation an automatic governor. The purpose of this governor is to stop the compressor motor when the desired maximum air pressure has been reached, and to start it whenever this pressure falls below a predetermined minimum. The difference between the maximum and minimum pressures is usually ten pounds. The reliability of the governor is the most important factor in insuring continuity of service and a ready and positive control of the car by means of the air brake system.

Electric Hoisting Machinery—The Crocker-Wheeler Company of Ampere, N. J., have issued Bulletin No. 62 which deals with the subject of electric hoisting machinery. In this paper is pointed out the advantages which are to be derived by the use of electric motors. It goes on to show that these motors for operating all classes of hoisting machinery has, during the past few years, greatly increased on account of their special adaptability to this purpose. As compared with steam or pneumatic hoists, the motor driven machine have the great advantage of being able to dispense with the boiler or compressor, thus rendering them much easier to transport and at the same time doing away with the services of a fireman. Electric hoists are effectively employed on wharves and docks, for coaling, and for loading and discharging freight and cargoes. They are also used for handling all kinds of merchandise in warehouses. In the latter class of service one feature of great value is their freedom from fire danger, their operation being free from the sparks and ashes incidental to the steam hoists and the often resulting destructive fires.

What Cheap Electricity Means—According to the Bulletin issued by the Portland General Electric Company the sweeping reduction in the rates for electric lighting in Portland means more to the citizens of Portland and its suburbs than the bare announcement. This cut in rates from 20 cents to 15 cents a kilowatt hour, or 25 per cent. of the base rate, means that no home, no store, nor establishment of any nature need be without the manifold advantages of electric light and service any longer on the score of cost. Electricity with its multitudinous benefits is within the reach of everybody. In the household it means the blessings of electric flat irons, electric curling irons, electric chafing dishes, electric heaters and a hundred other strength saving conveniences. It means more electric signs flashing their messages of invitation and reminder to the purchasing public; it means that more stores will be independent of daylight. It means that merchandise will be better—more attractively—displayed. It means that the small store can be made as attractive a shopping resort as the big establishment. It means improved conditions for everybody, lighter homes, lighter stores, lighter hearts and lighter bills. Electrical conveniences in the home are ever present helps in wrestling with the hired help problem. The mistress of the house with an electric chafing dish at her elbow rises superior to the servant question.

The Metropolitan Water and Sewerage Board, of Boston, has recently awarded the contracts for the Arlington Water Works Station to the Allis-Chalmers Company, Milwaukee. The equipment to be furnished is a horizontal, compound, condensing pumping engine, having a capacity of one and one-half million U. S. gallons in twenty-four hours against a head of 290 feet. This engine is one of a new line of small horizontal engines designed recently by the Allis-Chalmers Company to replace pumping engines of the direct acting type. It is claimed that the saving in steam consumption in this type of engine is from 20 per cent. to 50 per cent. less then for an engine under similar working conditions.

INDUSTRIAL

PIERSON, ROEDING & CO., INC., FORMERLY JNO. MARTIN & CO.

THE old and well known firm of Jno. Martin & Co., will soon pass from view as a factor in the electrical business, as the interests identified with that concern have formed a new corporation known as Pierson, Roeding and Company, which has taken over the entire business of Jno. Martin & Co. and of the Martin Pipe and Foundry Company. As is well known to the electrical men on the Coast, Jno. Martin has not been associated actively with Jno. Martin & Co. for the past three years, his interests in the concern having been taken over by F. H. Pierson, H. U. Roeding and H. R. Noack, who have had the exclusive control of the business of the company since Mr. Martin's retirement. It is but natural that these gentlemen (who have associated with them S. K. Colby of New York) should desire to do business under their own names, and they have accordingly taken the step above indicated, and now appear before the public under the name of Pierson, Roeding and Company.

The new company is merely a consolidation of Jno. Martin & Co. and the Martin Pipe and Foundry Company, retaining the entire interests of the two older concerns, as well as the same management, the same working force, the same agencies, and the same business address, together with all of the interests and accounts of the companies which are being consolidated.

The gentlemen comprising the company are: F. H. Pierson, president; H. R. Noack, vice-president; H. U. Roeding, secretary; S. K. Colby, treasurer.

With the possible exception of Mr. Colby, these gentlemen need no introduction on the Pacific Coast. Mr. Colby has been associated with Jno. Martin & Co. for the past six months, having relinquished the management of the New York office of the Pittsburgh Reduction Company in order to form his present connection.

The business of the concern has grown to such an extent that it has been found necessary to open branch offices in both Seattle and Los Angeles, the former office being located in the Colman Building under the management of R. H. Husbands; and the latter in the Pacific Electric Building under the management of H. C. Hopkins.

Pierson, Roeding and Company will continue to act as exclusive Pacific Coast agents for the entire list of companies previously represented by Jno. Martin & Co. Amongst the more important of these may be mentioned The Locke Insulator Manufacturing Company, of Victor, New York; The Pittsburgh Reduction Company, Pittsburgh, Pa.; The Lombard Governor Company, Ashland, Mass.; The Ohio Brass Company, Mansfield, O.; The Dimmick Pipe Company, and The Coosa Pipe and Foundry Company, of Birmingham, Ala.; The Fibre Conduit Company, Orangeburg, N. Y.; Schaper Construction Material Company, New York City.

The Locke Insulator Manufacturing Company, who have obtained such an enviable reputation on the Pacific Coast for the quality of their high potential insulators and pole line specialties, have found it necessary to practically double their capacity in the past few months, and for this purpose have erected a new factory building of reinforced concrete, and are now just beginning to turn their first product out of the new works.

The Pittsburgh Reduction Company, manufacturers of aluminum for electrical conductors, are experiencing considerable difficulty in taking care of all of the orders for aluminum wire which are being offered to them. The success of this material as an electrical conductor during the past few years has overcome all of the objections to its use, and it can be safely stated that the principal engineers on the Pacific Coast are now advising their constituents to place this metal upon a par with any other conductor.

The Lombard Governor Company, since their removal to their new and enlarged factory at Ashland, Mass., have more than doubled their output of hydraulic water wheel governors and relief valves. As there seems to be a constantly increasing demand for their product, they are contemplating still further additions.

The Ohio Brass Company, manufacturers of high grade overhead railway material, rail bonds, and electric railway specialties, have recently appointed Pierson, Roeding and Company as their exclusive Pacific Coast representatives. Owing to the extensive amount of electric railway development on the Coast, there is every indication that this well known concern will soon obtain the prominence in the West that it enjoys in the East and Middle West.

The Dimmick Pipe Company and the Coosa Pipe and Foundry Company, of Birmingham, Ala., manufacture water and gas pipe, and soil pipe, respectively, and both enjoy the distinction of furnishing only the highest grade of material. Both of these companies have previously been represented by the Martin Pipe and Foundry Company, which has now been consolidated with Pierson, Roeding and Company.

Among the other concerns doing business through Pierson, Roeding and Company may be mentioned the Fibre Conduit Company, Orangeburg, New York, who manufacture a high grade of underground electrical conduit which has met with considerable favor in this country and in England, but has not as yet been extensively introduced on the Pacific Coast; the Schaper Construction Material Company, of New York City, are offering a complete line of pole line hardware, including cross-arm braces, pole steps, bolts and lag crews, and other specialties; the Hardwood Planing Mills Company, of San Jose, manufacturers of eucalyptus insulator pins for high tension work.

With the above array of representative manufacturing concerns, offering as they do the highest grade of material in their respective lines, it is needless to state that Pierson, Roeding and Company expect to maintain the same position in the electrical field as has been occupied by Jno. Martin & Co. for so many years, particularly owing to the fact that the same interests are identified with the new company as with the old.

Chas. C. Moore & Co., has been awarded the contract for a Snow cross compound high duty crank and fly wheel condensing pumping engine, for the City of Stockton. This engine will have a capacity of 6,000,000 gallons in twenty-four hours against a total water pressure of sixty-five pounds. This engine represents the highest type of construction on this line for which the Snow steam pump people are noted. This pumping engine, it will be remembered, is being built by the same people who have the contract for the four large Snow power gas engines, each being rated at 5400 horsepower.

ELECTRICITY AS APPLIED TO COMMERCIAL ADVERTISING.

BY BURY IRWIN DASENT.

THIS is truly the age of pictorial advertising. I never pick up a magazine without getting pleasure from a perusal of its pictured pages of advertising matter. But I am getting ahead of my subject.

What I really meant to say was that this is truly an age of tremendous progress. An age in which the rate of progression is astounding, not so much because of its radicalism, but rather because of the rapid readjustment of methods to meet the volatile vagaries of commercial conditions, that ceaseless ebb and flow of the great tides of trade, which is subject only to the immutable law of supply and demand. And so, when I scan the pictorially embellished advertising section of the multitudinous magazine whose name is legion, it is with a keen realization of the conditions to which these pages form natural sequence.

FOURTH AND WASHINGTON, A POPULAR CORNER THAT'S ABLAZE WITH ELECTRIC SIGNS

All of which brings us back to the statement that this is the age of pictorial advertising.

At first it was the "word picture"—that faultless flow of rhetoric which possessed so fully the power of attraction and persuasion, and the "human interest" which sold the goods. Thus the idea of the "picture" found favor. Then the illustrators were called in to develop it, and so it has come to pass that we have been progressing through an epoch of advertising enhanced by the pencil of the artist, no less than the illustrator, as his commercial exemplar has been more commonly styled.

Remorselessly the conditions are changing, however.

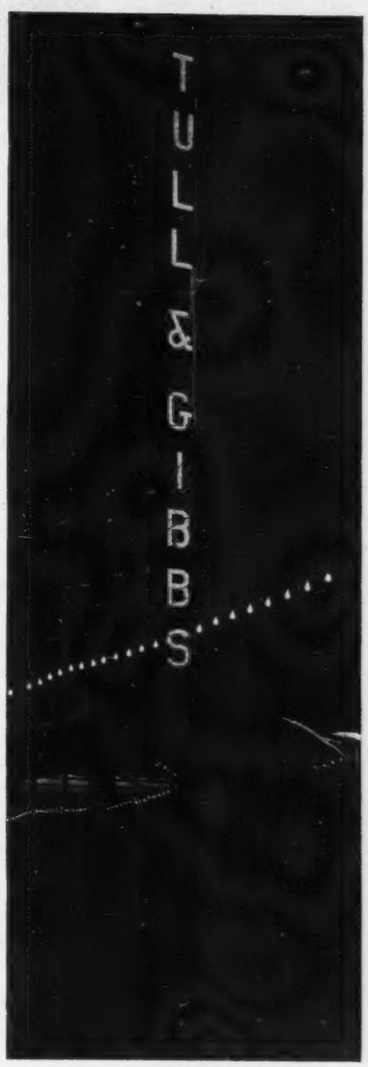
The kaleidoscope of business is evolving a new point of view from the old conditions. There is a newer picture forming in the public eye—it is the electric sign.

The "sign" of the times. A symbol which represents the business idea so completely that its advent has metamorphosed commercial conditions as related to publicity, changed the sky line of the great cities, and is gradually bringing about a peaceable revolution in aggressive advertising.

When the occasion is extraordinary and the demonstration is required to be of equally impressive proportions the tendency is to call for the assistance of the electrical people, who, be it said to their credit, are ever ready to respond, and with results both striking and artistic.

But it is with the normal conditions of business publicity we must reckon. The velocity of the gale leaves no doubt as to its direction, but during periods of ordinary weather straws may be counted on, with tolerable accuracy, to show which way the wind blows. I have in mind a recent communication from the New Orleans Light and Power Company to Arthur Williams of the New York Edison Company, in which an instance is cited where a New Orleans commercial college, having installed an attractive electric sign, was so overwhelmed with appli-

AN EFFECTIVE HOTEL SIGN



A SIGN THAT SELLS GOODS

cations for admission that they were forced to refuse further matriculation until the college could be removed into a larger building.

Trade does follow the light, and electrically lighted signs may be relied on to attract to any thoroughfare that great army of buyers whose opportunities for leisurely observation are mainly during the hours of the evening, after the day's work is done.

The most striking evidence of the value of electric signs as advertising media is the enormous increase in their use by business concerns of every nature.

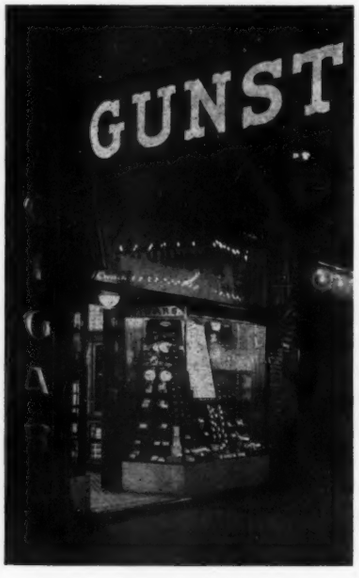
The merchants of Portland, with that characteristic enterprise which impelled them to the creation of the magic exposition city on the shores of Guilds Lake last year, have not been slow in recognizing the superlative efficiency of the electric sign as a high class, profitable and permanent form of advertising. These blazing banners of business, literally burning their messages into the minds of thousands nightly, have multiplied and increased to a prodigious extent throughout the city.

EFFECTIVE USE OF INCANDESCENT LIGHTS OUTLINING MEIER & FRANK COMPANY'S DEPARTMENT STORE BUILDING, AND INTERIOR ELECTRIC ILLUMINATION

The fiery electric signal has beoame in truth "the sign" of the progressive merchant, and takes its place as a matter of course in the equipment of every high class and up-to-date establishment.

That the purchasing public is no less quick to perceive and commend these evidences of enterprise is proven by the undisputed fact that the crowds of buyers gather where electric signs are most in evidence and where the lights are brightest.

It is a curious anachronism in the history of merchandising that at this up-to-date period there should be found a merchant who believes that people in general go to sleep at sundown. Yet that is the implied attitude of a few, for their signs can only be seen at daylight, and at a time when, as a rule, people are neither looking for signs nor are impressed by such commonplaces as the conventional painted boards which cap the entrance to every establishment be it big or little. The mere statement that the number of electric signs in Portland has increased more than 50 per cent. within the last year is proof positive that it pays to have them, and that merchants are beginning to realize their possibilities as trade bringers and are not waiting to feel the bad effects of not having them. The electric signs do not attempt to compete with circular advertising or newspaper display advertising. They do not attempt to take the place of any of the various methods of securing publicity. They have their own distinct and particular field, in which they are absolutely preeminent. They reach the person on the street as no printed advertisement can. They reach him or her at a time when the idea of purchase inspired by the sign can be most conveniently acted upon. It is the immediate, passing throng that is influenced by the ordinary electric sign. The influence is not temporary, however, for if the person is not persuaded then, he will be on a future occasion, for the electric sign is there by day as well as by night, and as every advertiser well knows it is the "keeping eternally at it" that spells "success."



EFFECTIVE CIGAR STORE ILLUMINATION IN THIRD STREET, NEAR STARK STREET

No merchant can afford to neglect this invaluable means of publicity, especially when he can have an electric sign of his own choosing installed and connected at his place of business free of charge, he agreeing to pay only for the current consumed, as is the plan pursued by the Portland General Electric Company.

Contrary to general belief the cost of electric sign advertising is extremely small when compared with the other forms of advertising. A Portland business concern having an unusually large and attractive sign recently found that the cost of the sign per year was less than for one prominent insertion of their advertisement in a newspaper.

To the merchant who is in doubt as to whether his advertising is attracting the attention which the expenditure warrants him in expecting, I shall have this to say concerning electric signs: Everybody reads electric signs and the mer-

chant's name, the name of his place or product, will simply be burned into the brain of the public if written in these witching letters of light.

That the electric sign must be accounted high up among the best modern methods of advertising, is proved by its adaptability to all kinds of business, large and small; its location, being in direct connection with the business which it is advertising, its attractiveness, its simplicity and its economy. All these stamp it the only way, the immediate way to gain immediate results.

If it were possible to estimate the advertising value of the electric sign in some such manner as the value of advertising space in the important publications of the country is arrived at, the result would indeed, be amazing.

Advertising rates of these publications, as is generally understood, are figured at so much per thousand of circulation, for that is an absolutely accurate basis of known value, just alike to the publisher as to the advertiser.

But who shall say what basis would be equitable in determining the value of advertising by means of electric signs? There is absolutely no limit to the "circulation" of an electric sign. We may agree par example that because the population of Portland is 150,000, that figure represents the high-water mark to our customers who use electric signs; but we must not overlook the fact that railroads and steamboats bring to the city new arrivals every day—indeed, every hour.

The population of greater New York is estimated at something over four millions, but who shall determine the "circulation" of the monster Butterick sign, the largest electric sign in the world a single letter of which measures sixty (60) feet, the sign that has changed the sky-line of New York City.

The railroads entering New York bring 200,000 passengers every twenty-four hours, to say nothing of the arrivals by steamship

It is my firm belief that the field of exploitation by means of the electric sign has barely been scratched, the marvelous possibilities of electricity as a means of publicity as applied to commercial and allied conditions is limited only by the imagination, and this branch of its business must eventually be recognized as of paramount importance to the electric central station.

ELECTRIFICATION OF THE PENNSYLVANIA RAILROAD.

TO the present time the principal advance in the electrification of steam roads has taken place at the terminal stations or upon branch roads, so that the recent decision of the Pennsylvania Railroad to equip electrically a portion of their system between Camden and Atlantic City, New Jersey, is of great interest. The developments which have taken place at New York under the direction of the New York Central and the New York, New Haven and Hartford railroad companies, have focussed the attention of the engineering world on this branch of railroad engineering and this further advance of electric traction, coming as it does when this phase of railroading is fresh in the minds of all engineers, marks another milestone passed in the substitution of electricity for steam for railway service.

That portion of the Pennsylvania Railroad to be electrified comprises some sixty-four miles of steam road lying between Camden and Atlantic City, New Jersey, being a portion of the West Jersey and Seashore branch of the Pennsylvania system. It is proposed to utilize the Cape May line of this system from Camden as far as Newfield, this line being double tracked with 100 pound rails, and to build an additional track from Newfield to Atlantic City, making the lines double track throughout.

Over this roadbed an express service will be established. The initial installation will provide for a three-car train every fifteen minutes between Camden and Atlantic City, making sixty-four miles in eighty minutes without stops. The maximum speed of the cars will be between fifty-five and sixty miles per hour.

In addition to this through service to Atlantic City, a half hourly scheduled is planned, consisting of two-car trains between Camden and Millville, forty miles, and ten minute service of single cars between Camden and Woodbury, eight and one-half miles. Full service will call for fifty-eight cars in operation, each equipped with two 200 horsepower direct current motors known as GE–69. These motors will be similar to those now being manufactured by the General Electric Company for the equipment of the New York terminal of New York Central and Hudson River Railroad. The motors will be controlled by the Sprague-General Electric automatic multiple unit system, which will permit the operation of cars in trains, all of the motors being under the control of the motorman in the cab of the forward car.

The current will be furnished to the cars by the third-rail system, except on the sections between Camden and Woodbury and Newfield and Millville, where the cars will obtain the necessary current by an overhead trolley. The speed on these sections is less than on the main line.

The power house will be located at Camden. The power for the operation of the cars will be furnished by three 2000-kilowatt General Electric-Curtis turbo-generators of the three-phase alternating current type, having a frequency of twenty-five cycles. From this power house transmission lines will be run to six substations between Camden and Atlantic City, and a seventh substation at Millville to supply that section of the road lying between Millville and Newfield.

The transmitting potential will be 33,000 volts. At the substations a total capacity of 11,000 kilowatts in rotary converters will be provided, delivering direct current to the third rail at 650 volts. The individual units will be of the standard General Electric type, and will have a capacity of 750 kilowatts. They will be started from the alternating current end by means of taps on the step-down transformers.

The contract calls for the completion of this road by July 1, 1906, in order to take care of the heavy summer traffic. The total amount of money involved is about $3,000,000. The electrical equipment will be furnished by the General Electric Company.

AMERICAN ELECTRICAL NOVELTY AND MANUFACTURING COMPANY.

THIS progressive company, whose main plant is located at Spring, Hudson and Vandam Streets, New York City, having branch factories in London, Paris, Berlin, Leipsig, Sydney, Australia, Montreal, Canada, Boston and Chicago, have established a branch factory and salesrooms at 572 Mission Street, San Francisco. With this complete establishment just started, they are more than ever entitled to be termed "The Standard of the World," on their famous line of "Ever Ready" electrical novelties, pocket flash lights, dry batteries, etc.

"EVER READY" ELECTRIC CLOCK

The San Francisco factory was started on account of the phenomenal demand for "Ever Ready" goods on the Pacific Coast and for the reason that the life of the dry batteries made fresh in the section in which they are used will be from thirty to sixty days longer, which, on the pocket flash lights and novelties, particularly, means a wonderful inducement to the trade as well as to the consumer. The factory contains 20,000 feet of floor space and is equipped with the newest and most up-to-date machinery, thus enabling them to manufacture here a full line of their specialties and guarantee prompt and immediate deliveries on all their lines. The advantage of this will be manifest to those who have had experience in the past waiting for Eastern deliveries.

Particular attention will be devoted to the Standard "Ever Ready" dry cells, this company having solved the problem of making a battery which shows a wonderfully high initial amperage and marvelous recuperative power and still has the life. Fully 75 per cent. of the manufacturers of automobiles, motor boats and all machines using gas and gasoline engines, also telephone companies, are using "Ever Ready" dry batteries exclusively, and when it is taken into consideration that this article has been on the market only a little less than two years, it certainly goes to show the wonderful merit of same. They will also manufacture a cheaper grade of dry battery than the "Ever Ready" in order to supply the demand for something at a less price for bell work, etc.

"EVER READY" COMET FLASH LIGHT

The Jury of Awards at the Lewis and Clark Centennial Exposition awarded to the famous "Ever Ready" dry cell the gold medal, the very highest award, against all competing batteries, whether exhibited or not. The "Ever Ready" exhibit of electrical novelties, etc, in the Manufacturers' Building, was voted the most attractive in the entire exposition. This line also received first prize at the Paris Exposition in 1900 and at St. Louis World's Fair in 1904.

This company is also owner of the American Miniature and Decorative Lamp Company and manufacture a complete line of miniature lamps of all descriptions, including telephone lamps, candelabra lamps, decorative lamps, novelty lamps, surgical and dental lamps, etc., a complete stock of which will be carried in the San Francisco warerooms. The merit of their goods in this line may be judged by the fact that this company did 70 per cent. of the miniature lamp business of the United States during 1905.

"EVER READY" MINER'S FLASH LIGHT

One of the principal articles manufactured is the "Ever Ready" Plato clock, which has no hands or dials and which has just been changed from a one-day to an eight-day movement. This clock has been on the market for some time and has grown immensely in popularity, as it is conceded to be the proper system of telling the time of day. It has been improved in a great many other ways and is positively guaranteed to be perfect in every detail.

Another clock, the "Keyless," for wall use in halls, public buildings, stores, offices, etc., is wound by a set of three "Ever Ready" six-inch dry cells, one set being positively guaranteed to run the clock from one to one and one-half years without winding.

"EVER READY" ELECTRIC CANDELABRA

This problem of manufacturing a perfect electric clock has at last been solved by combining the skill of the electrician, the mechanic and watchmaker, whereas in the past each in turn has made a failure of same through lack of knowledge of the other branches.

The officers of this concern also control the Auto Improvement Company, a corporation established for the manufacture of automobile specialties and improvements, the most notable of which, the "Ever Ready" automatic automobile starter, created the greatest sensation of anything at the recent automobile show in New York, and will revolutionize things in the automobile world. This wonderful invention can be attached to any automobile, launch or engine using gas or gasoline as motive power, and is positively guaranteed to start same by placing the foot upon a lever, thereby doing away with the necessity of cranking, which on automobiles particularly is annoying and embarrassing, as well as dangerous.

This is only one of a half-dozen new inventions now in course of manufacture. Among others are the "Ever Ready" gasoline filler, a new device for dispensing with the old fashioned filling funnels with their attendant nuisances and danger.

Another, the "Ever Ready" trip detector, fills a long felt want as an absolute safeguard against surreptitious or unauthorized use of the automobile during the owner's absence from the garage.

All of these improvements will be absolutely under the control of the American Electric Novelty and Manufacturing Company, and can be obtained only through them.

"EVER READY" VEST POCKET FLASH LIGHT

This company manufactures, among other things, the famous "Ever Ready" electric gas and range lighters, electric cigar lighters, Christmas tree outfits, electric scarf pins, electric signs, "Ever Ready" ammeters, electric toy engines, electrical alarm clocks, candlesticks, electrical surgical and dental lamps, medical coils—in fact, everything in the line of electrical novelties.

The Pacific Coast branch, covering also the Pacific Northwest, is under the management of R. F. Oakes, a member of the firm, who will be the resident manager and have full charge of the business in this section. Mr. Oakes is an Eastern man, who has been for the past few years president of the Eastern Manufacturers' Company, of Portland, Or., Northwestern representatives of the American Electrical Novelty and Manufacturing Company, and is thoroughly familiar with the wants of the Pacific Coast trade and their ways of doing business.

Hunt, Mirk and Co., Inc., engineers, of San Francisco, have recently closed several contracts for power plant equipment containing Westinghouse-Parsons turbo-generators. With the North Mountain Power Company, Eureka, Cal., for a 500-kilowatt turbo-generator, sixty cycles, three-phase, 2400 volts; also with the Los Angeles-Pacific Company for a 2750-kilowatt turbo-generator, 6000 alternations, three-phase, 15,000 volts including complete condensing equipment.

THE SINGLE-PHASE ELECTRIC LOCOMOTIVES AND POWER EQUIPMENT OF THE ST. CLAIR TUNNEL COMPANY.

THE single-phase electric locomotive adopted by the St. Clair Tunnel Company for the operation of the St. Clair tunnel, which connects the American and Canadian divisions of the Grand Trunk Railway System, will weigh approximately sixty-two tons and will develop a draw-bar pull of 25,000 pounds on a 2 per cent. grade at a speed of ten miles per hour. It is of the rigid frame type with driving axle boxes held in the same frame that contains the draft gears It will be mounted on three pairs of driving wheels which will sustain the entire weight, distributed by equalizer bars similar to those used in steam locomotive practice, will have an outside frame supported on semi-elliptical springs, and will be equipped with Westinghouse friction draft gear, MCB automatic couplings, air sanding apparatus, and bumper steps, front and back. The cab will be of sheet steel mounted on a frame work of iron which supports both walls and roof.

The principal dimensions will be approximately as follows: Length over end sills, twenty-seven feet nine inches; rigid wheel base, twelve feet; width over all, nine feet six inches; height from top of rail to top of cab, twelve feet six inches; diameter of driving wheels, sixty-two inches.

The operating apparatus will be arranged along the sides of the cab, leaving a free passage-way three and one-half feet wide the entire length. The cab will be lighted and heated by electricity, arrangement being made to screen the instrument lights while the locomotive is running.

Westinghouse combination automatic and straight air and American driver brakes will be used. The air supply will be provided by a two-cylinder motor-driven air compressor having, with a five-inch stroke and speed of 190 revolutions per minute, a capacity of forty-five cubic feet of air per minute. Air reservoirs, signal outfits, whistle, bell with pneumatic ringers, automatic pump governor, tools, instruments, gauges, headlights, push poles and other details complete the auxiliary equipment.

A motor will be geared to each axle, giving each unit an aggregate rated capacity of 750 horsepower. They are of the Westinghouse single-phase, alternating current, series wound, compensating type, whose successful development was first publicly announced in the notable paper read by B. G. Lamme before the American Institute of Electrical Engineers in New York, September 26, 1902. They are of the same general character as the motors selected by the New York, New Haven and Hartford Railroad Company for the operation of their line between New Haven and New York. Each motor will weigh complete approximately 14,500 pounds, the armature weighing approximately 5600 pounds.

The motor frame consists of a steel cylinder cast in one piece and enclosed at the end by brackets of the same material, which carry the bearings and oil reservoirs. The suspension noses and safety lugs form a part of the main casting. Seats for the axle bearings are cast solid with the frame. All bearings are of phosphor-bronze lined with babbitt and are divided into two parts. They are of exceptionally large dimensions, are arranged for oil waste lubrication, and are provided with large openings on the low pressure side, giving a thorough lubrication to the entire bearing surface. Oil is fed into the reservoirs through openings separate from the waste pockets and therefore reaches the waste from below and is thoroughly filtered before entering the bearing.

The motors are swung between the locomotive frame and the driving axles by a flexible nose suspension from two hangers supported by a truck transom and passing through heavy lugs with helical springs above and below the lug. The motors are held to the axle by means of caps which are split at an angle of thirty-five degrees with the perpendicular, so that the greater part of the weight is borne by solid projections from the motor frame which extend over the axle rather than by the cap belts. Large openings above and below provide access to the commutator and brush holders.

Within the cylinder of the motor frame there is built up a core of soft steel punchings, forming a complete laminated field. The punchings dovetailed into the frame and clamped between end rings of cast steel. The field coils are wound with copper strap insulated between turns and about the coils by mica and finished by taping and dipping, and are impregnated in the best grade of varnishes, providing a sealed coil which can withstand the most severe internal heat and is practically indestructible under the usual conditions of heavy railroad service.

In addition to the main coils the field carries a neutralizing winding which consists of copper bars placed in slots in the pole faces and joined at the ends by connectors of copper strap, so as to form one continuous winding which is connected in series with the main field winding and with the armature circuit. The magnetizing effect of this auxiliary winding is directly opposite to and neutralizes that of the armature winding, thus eliminating the effect of armature re-action and improving communication and power factor. The main coils can be easily removed without disturbing the auxiliary winding.

The armature cores are formed of slotted soft steel punchings built upon a spider and keyed in place. The spider is forced upon the shaft with heavy pressure and secured by a steel key. Coils of copper strap are embedded in the slots and joined to form a closed multi-circuit winding which is cross-connected, like the multi-circuit winding of a direct current generator. The basis of the insulation is mica. A preventive winding is connected between the commutator and the main coils, introducing a preventive action which is effective only when the coil is passing under the brush.

During operation a forced circulation of air supplied by motor-driven blowers enters at the rear, distributes itself thoroughly throughout the motor and escapes through the perforated cover over the commutator. This system of forced ventilation of both motors and auxiliary apparatus forms one of the most interesting innovations in electric railway construction. It secures a maximum output from a given weight of material, and a high ratio of continuous output to the one-hour motor rating common in railway practice. It also prevents effective ventilation while the locomotive is not in operation as the blower may be driven while the locomotive is standing at the station or at the end of the line. Motors ventilated in this manner are enclosed and are thereby protected from internal damage by dirt and water and from mechanical injury.

These motors are wound for 240 volts and twenty-five cycles per second and have a nominal rating of 250 horsepower each, on the basis of usual electric railway practice.

The essential elements of the control equipment include the collecting devices, the auto-transformers, the unit switches, the preventive coils, the reverser and master controllers. A multi-unit system of control is provided with pneumatically operated switches and circuit breakers, low voltage control circuit, and other characteristics standard in Westinghouse practice. Any unit may be controlled from either end, and two or more units may be coupled together and operated from a single cab and by a single crew. The tractive effort which can be readily applied to a single train is therefore limited only by the number of units available, and the hauling power is limited only by the mechanical strength of coupling between locomotive and cars. A control circuit is carried from one unit to the next by means of connecting sockets and jumpers in the usual manner.

Speed control of the driving motors is secured by variation of the voltage at the motors obtained by means of taps taken from the winding of the auto-transformer which receives current from the trolley at 3000 volts and reduces it to 240 volts or lower, according to the tap employed. These taps are connected to unit switches from which current is led through the preventive coils to the motors. Four unit switches serve to reverse the field of each motor.

The unit switches are of standard Westinghouse design and are, in effect, pneumatically operated circuit breakers of great power and reliability. The mechanism is such that a rolling and sliding contact is obtained when the switch closes and opens. The air is broken at the taps, leaving the contact surfaces smooth and unscarred. Each unit has a magnetic blow-out coil with laminated core. The switch cylinders are controlled by magnetically operated valves, current for which is obtained from a fifty-volt tap from the auto-transformer. The sequence of operation is governed by the master controller in conjunction with a system of inter-locks which prevents short circuits of the steps between taps from the auto-transformer or improper operation of the controlling mechanism. At any running point four controlling switches are closed. Through the preventive coils approximately the same amount of current is drawn from each of these switches and the leads to which they are connected. To change to a higher voltage on the motors, the master controller is moved to the next notch, opening the last switch of the group that is closed and closing the switch next higher, with the result that the motor voltage is shifted up one step. By this arrangement the voltage at the motor will be completely under control of the locomotive driver and may be varied up and down at will without opening more than one-quarter of the load current. Small switches in the circuits to the magnets of the reversing switches will enable any motor or combination of motors to be cut out without disturbing the others.

Every one of the seventeen controlling connections provides an efficient running point. This number is ample to prevent any slipping of the driving wheels due to increase of current from one notch to another. Whether empty or heavily loaded, operated in single or multiple units, torque and draw-bar pull may be gradually applied and the locomotive started without jar.

Each locomotive unit will be equipped with a pneumatically operated pantagraph trolley to collect current from the overhead lines outside the tunnel and throughout the yards. The proportions of the pantagraph will be such that, when extended, it will make contact with the trolley wire twenty-two feet above the rail, and, when closed down, the contact shoe will not extend more than eighteen inches above the roof of the locomotive. The pantagraph will have a broad base and will be constructed of light and stiff material.

A No. 0000 grooved overhead trolley wire will be suspended from a single five-eighth-inch, high strength, double galvanized, steel strand, messenger cable by hangers of varying length in such a manner that the trolley wire will be approximately horizontal. The messenger cable will be swung from structural iron bridges located throughout the yards and are of suitable length to span the proper number of tracks. There will also be a small section of track equipped with a trolley line swung by catenary suspension from bracket arms which are supported on lattice-work poles.

For the operation of the electric locomotives a complete power plant will be installed by the St. Clair Tunnel Company, including two 1250-kilowatt, 3300 volts, three-phase, twenty-five-cycle, 1500 revolutions per minute, rotating field, Westinghouse steam turbine units with the necessary complement of switchboards, exciters, lightning protective apparatus, etc. This station will also supply current to light the buildings, yards and tunnel, to operate motor-driven centrifugal and triplex pumps which drain the tunnel and approaches and operate the sewage system, to run motors in the round houses and for other purposes.

The new equipment will handle that portion of the Grand Trunk Railway system which connects the divisions terminating at Port Huron, Mich., and Sarnia, Ont., on opposite sides of St. Clair River. The tunnel proper is 6032 feet long and the line to be electrically operated measures 19,348 feet from terminal to terminal.

A pair of new units will be capable of hauling a thousand-ton train through the tunnel without division. Mechanical considerations limit the advisable weight of train in the tunnel to these figures. Heavier trains can be divided or sent through together with locomotives in front and behind. The service requires that each unit shall take a train of 500 tons through the tunnel block from summit to summit in fifteen minutes, under the following conditions:

It will be coupled to the train on a level track at a point 1800 feet from the summit and must accelerate it up to a speed of twelve miles per hour in two minutes, at the end of which time it will have reached the summit of the grade leading down into the tunnel. It will then run down a grade of 2 per cent. to the level track in the tunnel at a speed not exceeding twenty-five miles per hour, continue on the practically level stretch under the river, and then draw the train up a 2 per cent. grade at the rate of ten miles per hour to the level track beyond the tunnel approach on the other side. It must then gradually accelerate the train until a speed of eighteen miles per hour is reached. Each unit must be capable of exerting a tractive effort of 25,000 pounds for a period of five minutes in addition to the energy required to accelerate the train at the starting point and to run with it into the terminal yard, from which point it must immediately run back to a position 1200 feet from the summit, couple to another train and be ready to start through the tuunel in the opposite direction. It must therefore make a run of the character described every thirty minutes.

Six of these locomotives are to be furnished by the Westinghouse Company. It is expected that the electric equipment will greatly relieve the traffic congestion now existing and due in a large measure to the necessity of dividing trains at the terminal points, and to greatly simplify the operation of the road. Its opening will mark the progress of electrical methods in the railway field under conditions which seem peculiarly fitted to demonstrate its practical advantages in heavy service. That single-phase system has been adopted for so important an undertaking makes evident the recognition accorded the alternating current by railway engineers, and indicates that its claims have been verified by the service already rendered.

The work of installation will be conducted under the supervision of Bion J. Arnold, of Chicago, consulting engineer for the tunnel company, by whom the plans and specifications were prepared. Mr. Arnold was one of the first engineers in America to advocate the employment of the single-phase, alternating current system in railway service.

THE UNITED STATES CONSTRUCTION AND SUPPLY COMPANY.

THE United States Construction and Supply Company, Inc., has recently begun business, with offices on the fourth floor, Examiner Building, Los Angeles, Cal. This company has a complete organization, each director being a specialist and having charge as department superintendent of the branch in which he has had experience. The staff is as follows:

E. Stiernlov, architectural department; H. A. Dunlap, structural department; J. C. Green, electrical department; W. S. Madick, decorating department; A. C. Dale, sanitary and heating department; J. T. Webb, plastering and stucco department; H. Bobbitt, masonary department. These officers are also supervisors of all work that comes under their respective departments. The buying and ordering of material is left to the respective superintendents.

The National Electric Company, of Milwaukee, has secured the contract for a 250-kilowatt engine type alternating current generator for the City of Alameda municipal lighting plant. This is the second order received by the National Electric Company as the city already has one 250-kilowatt generator of the National Company's make installed in their power house.

Mr. D. Ben Replogle, representing the Replogle Governor Works, of Akron, O., has established headquarters at 142 First Street, San Francisco.

PUMPING PLANT FOR THE ISLANDS.

THE Makee Sugar Company, Kaila, Island of Kauai, Hawaiian Territory, of which Z. S. Spalding is president, is having furnished by Allis-Chalmers Company the complete pumping outfit for an irrigation system.

The primary driver will consist of a specially designed impulse water wheel, operating under a fall of 400 feet of water conveyed in penstock pipes from a mountain stream and delivering its power continuously to a Bullock alternating current generator, direct connected, at six maximum speeds, which are secured by the use of six different sets of buckets arranged on wheels of varying diameters.

As is the experience with mountain streams elsewhere, the quantity of water Mr. Spalding has available for power varies considerably at different seasons; hence, he wishes at all times to utilize, as far as practicable, the maximum water supply, and, in order to get the full benefit from the quantity available at any time, it has been necessary to evolve a scheme by which speed of the pump can be varied in proportion to the flow at the source of power.

The head being constant, the velocity of the water at the delivery nozzle is constant, and the horsepower varies directly with the water supply. By changing the dimensions of the wheel carrying the buckets, the rotative speed of the generator is changed, while the speed of the water remains constant at all times. With constant field strength on the generator, the voltage will be directly proportional to the rotative speed and as, the cycles are also proportional to the rotative speed, it will be seen that the volts and cycles vary in a fixed ratio to each other.

The energy from the generator being delivered to an induction motor, the speed of the motor, and therefore of the pump, will change in the same proportion as the speed of the generator.

As both the frequency and the voltage change in the same ratio, the induction motor will at all times be operating under conditions corresponding to those for which it has been designed.

The generator is rated at 300 kilowatts, three-phase, sixty cycles, and will have a normal speed of 450 revolutions per minute.

The pumping plant will be located five miles from the power station. Here is to be installed a Bullock induction motor of 225 horsepower and this, by means of rope transmission, will drive a duplex, double-acting Riedler pump, having a capacity against 250 feet head (including friction) ranging from 1750 gallons per minute, when the water wheel has five cubic feet per second supply of water, to 2800 gallons per minute (4,032,000 gallons per twenty-four hours) with a supply of eight cubic feet per second at the wheel. The speed of the pump, operated at its full capacity, will be 116 revolutions per minute. It is to be extra heavy and furnished with Allis-Chalmers Company's latest improved mechanically-operated pump valves.

The generator will have its exciter, of eight kilowatts, direct connected to it, and the exciter has been so designed that it can deliver the full voltage and current required for excitation even at the minimum speed. By means of an automatic regulator, the exciter voltage will be maintained constant at all speeds of rotation and it will, therefore, be unnecessary to change the adjustment of the generator rheostat when the speed of the rotation is changed. In addition to the automatic regulator a hand operated field regulator will be installed for use in an emergency. It was the original intention to use at the pumping station a synchronous motor which would require a fifty horsepower motor for starting, as well as an exciter, controllers and apparatus for throwing the starting motor in or out; but it was found that the system could be simplified by the use of an induction motor. The operation of the plant remains otherwise practically the same, and of course the induction motor requires neither a starting motor nor exciter, but merely controlling apparatus. The efficiency of the whole plant will be the same with an induction motor as with a synchronous motor, while in simplicity of construction, reliability of operation, small amount of attention required and also in the matter of the first cost the induction motor has the advantage. Necessary by-pass valves are provided for use in starting up. Either side of the pump may be run separately when desired.

Many Riedler pumps have been installed directly driven by water wheels. On account of its high rotative speed, this type of pump is especially adapted for electric drive. In many cases the power may be directly connected to the crank shaft of the pump. There are but few cases in which more than single reduction is required. Because of the high number of revolutions for a given capacity, less water is pumped per stroke, and as the strokes occur with greater frequency, the continuity of flow in both suctions and discharge piping is kept up. The total work is thus more evenly distributed, severe shocks eliminated and the strains on driving machinery made uniform and reduced to a minimum.

PELTON TURBINE WATER WHEELS.

THE Pelton Water Wheel Company, of San Francisco and New York, advises that it is about to place on the market a new and improved type of turbine wheels, to be known as the "Pelton-Francis" turbine. As is generally understood, the Pelton wheel of the impulse type is essentially a high grade tangential wheel, adapted to heads from twenty-five feet and upwards; Pelton wheels being employed on all of the higher head water power plants in the world.

The prevailing tendency of the electrical manufacturers towards large units and high speeds has encouraged the development of the highest grade Pelton wheel units, built with particular reference to absolutely continuous service twenty-four hours a day and 365 days in the year, even for the largest units. Constructions of 10,000 horsepower capacity have now been in satisfactory operation for several years, and are being constantly called for to meet the increasing size of electrical equipments. To anticipate a demand for a high head and large capacity turbine, and to cover a wider hydraulic field, this company has obtained the services of an eminent German engineer of wide experience in this class of work, who with the engineering staff of the Pelton Water Wheel Company, has designed the type of wheel above referred to. This consists of a modification of the familiar "Francis" type of turbine, so well known in this country, Germany and Switzerland, with which are combined some of the special principles of the heretofore well known Pelton system. Preliminary tests show a remarkably high efficiency, while the design and construction are exceedingly simple and reliable.

The Pelton Company is now prepared to furnish complete estimates and specifications covering the "Pelton-Francis" turbines for all water pressures, and in connection with the Pelton wheel, is enabled to meet to the best advantage any conditions of head, speed and power.

A recent order for Pelton wheels is that of the Yukon Consolidated Gold Fields, a corporation in which the Guggenheim Exploration Company is largely interested. The order consists of two complete Pelton units operating under a head of 650 feet, each wheel being direct-connected to a 600-kilowatt 450 revolutions per minute, generator, provided with an over-load capacity of 1200 horsepower each. The power will be transmitted electrically and used in connection with dredging work on the Yukon River.

Another order is that of the Empire Electric Power and Irrigation Company, of Empire, Colo., who will install under a head of 560 feet a Pelton wheel of 1000 horsepower capacity, direct-connected to a 450 revolutions per minute generator. The exciter will be mounted on the end of the alternator shaft. Power will be transmitted to the mines and mills in the vicinity of Empire, Colo.

The Pelton Company is letting contracts for its new works in the Mission district of San Francisco, which are to be much larger and equipped with the latest and best tools, and expects to be established there by July 1st of this year.

THE ECONOMY AND EFFICIENCY OF THE STEAM TURBINE.

THE London *Times* is publishing a series of articles on steam turbines, which contain some very interesting data concerning the showing made by machines of the "Parsons" horizontal, multiple-expansion, parallel, full annular flow type, that are built in England by C. A. Parsons & Co., Willans & Robinson, and Richardson, Westgarth & Co., in Switzerland by Brown, Boveri & Co., and in the United States by the Allis-Chalmers Company, of Milwaukee, Wis.

Turbines of this form of construction, with an aggregate capacity of over 1,000,000 horsepower, are now operated in various cities of Europe and the United States for the generation of electric power. Several of the turbines in operation at the plant of the Newcastle Electric Supply Company are each capable of developing 6000 horsepower at 1200 revolutions, under normal conditions, and over 10,000 horsepower on overload. Turbines of similar size and design, put in operation in Switzerland by Messrs. Brown, Boveri & Co., are each designed for a normal output of 12,000 horsepower while similar progress is being made by French and Austrian engineers.

The success of marine turbines for torpedo boat destroyers and high speed passenger vessels has been so widely discussed, both in the technical and popular press, that very little remains to be said at the present time; but the *Times* makes some very significant comparisons showing the results attained with vessels of identical construction except for the type of engines used. The Amethyst and the Topaz, constructed after the same pattern, were selected by the British Admiralty for the purpose of making a series of exhaustive tests, the former being equipped with turbines and the latter with reciprocating engines. The contract speed of the vessels was twenty-one and three-fourths knots and the tests showed that at all speeds above fourteen and one-half knots the turbine-equipped Amethyst was more economical, namely, 15 per cent. at eighteen knots, 31 per cent. at twenty and one-half knots and 36 per cent. at twenty-one and one-tenth knots. At full power in each vessel the largest showed 42 per cent. more than required by contract on the coal allowed. The Amethyst also touched a speed of 23.5 knots during these tests and the Topaz only 22.1 knots.

More noteworthy results on a larger scale have recently been afforded by the trials of two Cunard liners, the Carmania and the Caronia, each of 30,000 tons displacement and 23,000 indicated horsepower, the former being fitted out with turbines and the latter with quadruple expansion engines of the latest design. Essential facts concerning the trials of these vessels have been widely published and generally read; but the statement that the Carmania beat the Caronia by about one knot does not give an adequate idea of the relative efficiency and economy of the turbines. It must be remembered that one knot in speed means about 16 per cent. more horsepower and that, therefore, the Carmania would appear to be about 16 per cent. more economical than her sister vessel driven by the most highly developed type of reciprocating engines; further, that the test of the Carmania was the first trial of turbines on so large a scale, and it may reasonably be expected that improvements in detail will improve upon the noteworthy results obtained. Members of the engineering profession will await with great interest the trials of the two gigantic Cunard turbine vessels of twenty-five knots speed and 60,000 to 70,000 horsepower now building on the Clyde and the Tyne.

The Golden Key Mining Company, Hillside, Ariz., is installing a power plant to operate its mining machinery and a contract has been closed for two of the well known "Hornsby-Akroyd" oil engines sixteen, horsepower each, built by the De La Vergne Machine Company, New York.

The Lunkenheimer Company, of Cincinnati, O., recently placed an order through the Cincinnati office of the Allis-Chalmers Company for a 425-kilowatt type A. I. generator unit.

THE JOHN M. KLEIN ELECTRICAL COMPANY.

IT is gratifying to learn that this company has added to its already large and complete line several new and valuable agencies for both standard and special electrical goods, which places them in a most admirable position to cater to the wants of the trade.

Some of the most prominent lines recently added are:

Minerallac Company, Chicago, electrical testing instruments and insulating compounds for high tension work. This is probably one of the most valuable additions, as it gives to this locality articles which have heretofore been unknown; and, from the results achieved in the East, the central stations of the Pacific Coast will find in this line, articles which have never been furnished for their use. A few of these are an absolute necessity to aid them in furnishing a continuous service, which has so frequently in the past been interrupted, due to breakdowns in high tension cables and apparatus. The new ground detector, manufactured by the Minerallac Company, is in a class by itself and fills a long felt want. The Minerallac Company manufactures a large number of very useful central station devices, other than those mentioned, which it will pay central station owners and managers to investigate.

Phillips Insulated Wire Company, "Parac" rubber covered wire, for which John M. Klein Company has secured the Pacific Coast agency, needs no introduction to the electrical trade. Suffice it to say that the reputation of the Phillips Company, established in the manufacture of its "O. K." weather-proof wire, is sufficient guarantee of the rubber-covered which they are producing.

Russell & Stoll, navy standard and commercial marine fittings. This company manufactures, without exception, the finest line of marine fittings on the market. They have furnished the marine fittings for the New York subway. They also have the contract for electrical fittings for use in the Pennsylvania tunnel, now in course of construction, in which they are installing marine apparatus which is unheard of in ordinary practice and unlisted in the electrical catalogues of the day.

Holtzer-Cabot Electric Company, house goods. This company and their excellent line of goods are well known to the electrical trade and need no introduction. The Klein Company will carry a full line of these standard and special goods at all times.

The electric sign department of the Klein Company's business, is increasing very rapidly; so rapidly, in fact, that it has been very difficult for the manufacturers of these porcelain enameled steel goods to keep them supplied with stock fast enough to fill their orders. However, shipments are being received daily and large orders for future delivery have been placed, which will enable them to keep pace with the demand for these goods.

The Columbia Theatre, in this city, has shown its appreciation of the exceptional qualities of the "Federal" porcelain enameled steel sign letters by having installed, over the entrance to the theatre, a "Federal" attraction sign, using these letters. This is a very attractive sign and shows the progressiveness of the Columbia management.

The Klein Company has also recently closed a contract for one of the largest vertical-letter signs ever installed in the United States; which, when completed, will be an everlasting monument to the energy and enterprise of one of San Francisco's largest stores.

The Klein Company shows, in their advertisement in this issue, another style of the "Federal" standard sign, which is intended for the small store-keeper whose business will not warrant the expense or operating cost of a regular lamp-letter electric sign. These are known as "Panel" signs and consist of porcelain enameled steel panels, containing the lettering of the sign, placed in a frame of galvanized iron which is thoroughly enameled with three coats of standard bicycle enamel, the sockets and wiring being concealed in the frame, the lettering on the panels being illuminated by the lamps in border of the frame on each side. These signs are very neat and well made, being all metal, fire,

rust and water-proof, equipped with the regular swing hanging-rig and can be swung back parallel to the building, if so desired.

The manager of the sign department of the Klein Company states that nearly all the large central stations in California are now negotiating with this company with a view to furnishing "Federal" signs to their customers on the proposition recently introduced and now in successful operation, and it is only a question of a short time when every central station on the Pacific Coast will realize the advantages accruing from this class of business, to which they have heretofore paid little or no attention.

The latest proposition, mentioned in another part of this paper, entitled "Large Returns; No Investment," is of interest to all central stations, large and small, and a line to the John M. Klein Electrical Company, 105 Battery Street, will bring forth the particulars of this original Pacific Coast proposition.

CALIFORNIA ELECTRICAL WORKS.

THE California Electrical Works has inaugurated a monthly publication in the interest of their business on the Pacific Coast. The object of this paper will be to keep their trade informed concerning goods of their own manufacture as well as the products of the many manufacturers they are representing. This booklet will undoubtedly prove of general interest, as it will be conducted on somewhat different lines than similar publications now before the public. The immense plants and organization of the company that extend throughout every important city in this and foreign countries should provide unlimited and interesting reading matter for its columns. The first number contains an article on their new San Francisco factory, as well as their new branch at Los Angeles; also the novel offer of a cash price of $25,00 to the party who suggests the best name for the paper. Its appearance is typical of the high grade printed matter sent out regularly by this company.

VARNISHED CAMBRIC CABLES.

THE success attending the use of varnished films for the insulation of high tension apparatus made by the General Electric Company, suggested the application of this principle to the insulation of wires and cables. After four years of careful development and prolonged tests, the manufacture of this type of cable was commenced in 1902. Its success was immediate and every initial installation has been followed by additional orders.

Specially prepared cotton fabric is coated on both sides with multiple films of insulating varnish of our own manufacture. The coated cloth is cut into strips and applied to the copper core with films of special non-drying, viscous and adhesive compound between the layers; a separator is applied between the copper core and the tapping to prevent any possible action of the varnished films on the copper. The result is a flexible and homogeneous insulating wall of great dielectric strength.

This type of insulation, like paper, will not allow the conductor to decentralize under either mechanical stress or high temperature. The insulation, unlike paper, does not absorb moisture and can be used for interior wiring without lead. It is, therefore, unnecessary to seal the ends. Varnished cambric is more flexible than paper and cables can be bent to a radius equal to six times their own diameter without injury.

CHANGE OF ADDRESS.

Announcement is made of a change in address of the Salt Lake City branch office of the Allis-Chalmers Company, Frank E. Marcy, district manager. After January 10th, the offices formerly located at 209 S. W. Temple Street, will be removed to the Dooly Building at 117-119 East Second South Street where they will be centrally located.

STEAM TURBINES IN MINING WORK.

WHEN it is recalled that the first successful steam engines were used for mining work to free the lower levels from water, it is unusually interesting to note to what extent the steam turbine has entered this field and that even from this well established place, the steam turbine is driving the reciprocating steam engine.

The well known economy of this form of prime mover at all loads has led to its wide adoption for mining power purposes in conjunction with electricity as the intermediary. Now that transportation by electric mining locomotives and mine lighting by electricity have become so well established as the most economical and safest methods in their respective lines, the steam turbo-generator is the logical source of necessary power.

The Curtis steam turbo-generator built by the General Electric Company, of Schenectady, New York, has met with much success in this class of work, and its adaptiveness to this field can, perhaps, be realized if some mention be made of the various kinds of mining in which it has been successfully adopted.

Seven 500-kilowatt, 2300-volt, sixty-cycle, alternating current generators driven by these turbines have been purchased by the Delaware, Lackawana and Western Railroad Company for operating mining locomotives and hoists in the coal mines at Scranton, Pa. Three of these machines were put in service in November, 1903, another has since been installed and an order has been placed for three additional machines which are now being installed at Nanticoke, Pa. Other Curtis turbines in process of construction for coal mining work are a 500-kilowatt machine at Iron Mountain, New York, for the Detroit and Hudson Railroad Company; one 1500-kilowatt and one seventy-five-kilowatt machine for the Cowanshannock Coal and Coke Company, at Echo, Pa., and two seventy-five-kilowatt Curtis steam turbo-generators for the North Jellico Coal Company, Louisville, Ky.

One of the most recent adaptations of the turbine in this work, is at Flat River, Mo. The Federal Lead Company will install three 500-kilowatt, four-stage, 480-volt, Curtis steam turbo-generators. These will operate at sixty cycles and three-phase for lighting and power work in the company's mines. A duplicate exciter system will be furnished, consisting of a twenty-five-kilowatt turbo-generator set. In addition to the above, the General Electric Company will also furnish a complete switchboard equipment for a three-phase power feeder system, and for four single-phase lighting circuits.

The Consolidated Gold Fields Company, of South Africa, has one 1000-kilowatt and three 500-kilowatt Curtis steam turbines in successful operation. In the same country also the Witwaters Rand Deep Mining Company operates a 500-kilowatt turbine, using the power so generated in gold mining. A 1000-kilowatt machine has been installed in the Miike Coal Mine, Japan. It is evident, therefore, that the turbine is meeting with much success in fields other than that of the electric railway. Not only suburban trolley systems, but also the recent developments in the electrification of trunk lines emphasize this point. Power for the operation of the Camden-Atlantic City portion of the Pennsylvania Railroad will be supplied by steam turbines, about 6000 kilowatts being furnished by Curtis turbo-generators for this purpose.

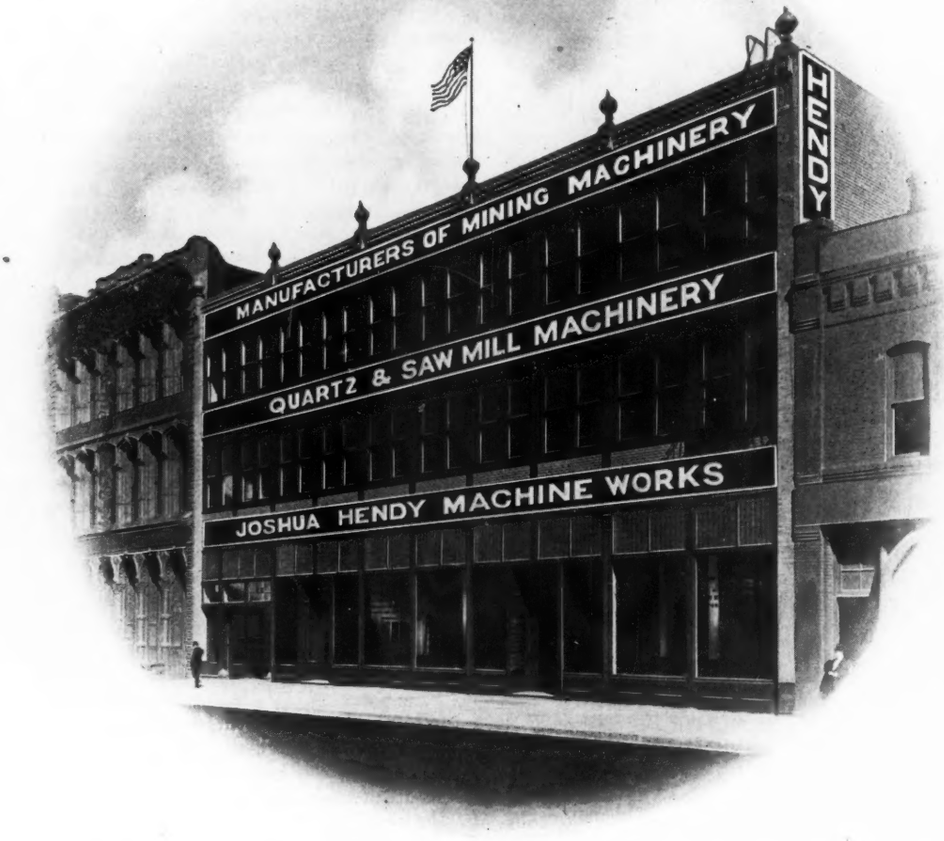
The Abner Doble Company, of San Francisco, announces that it has opened up a branch office in Los Angeles at 447 Pacific Electric Building. The company's business in the water wheel and machinery supply line had increased to such an extent that it became necessary to have better representation in the southwest. The new branch will have for its field southern California, Arizona and New Mexico and parts of Nevada and Mexico. L. Cummins will have charge of the office.

The Standard Electrical Works sold a twelve-kilowatt 125-volt set to the North Mountain Power Company, at Eureka, to be used as an exciter on a turbine generator set.

THE JOSHUA HENDY MACHINE WORKS.

THE Joshua Hendy Machine Works have joined the ranks of our advertisers, and present their announcement as representing for California the DeLaval Steam Turbine Company, of Trenton, N. J. The product of this company is well known and the fact of its local representation will no doubt interest our readers.

The Joshua Hendy Machine Works have recently relinquished their control of the Wagner-Bullock Electric Company, of California. The latter company having been a large factor during the last three years in the distribution of the Wagner Electric Company's machinery as well as that of the Bullock Electric Manufacturing Company. Therefore the Hendy's do not appear in this issue as strangers and in need of introduction. Since



September 1, 1905, last, the Joshua Hendy Machine Works have occupied their new and spacious salesrooms and offices on Fremont Street opposite their prior location in the Union Foundry Block, No. 38-44, and we illustrate here a half tone view of their premises which are without exception the finest appointed offices and salesrooms west of Chicago. Three floors with a frontage of 922 feet on Fremont Street by 137½ feet in depth are now allotted by this concern for the transaction of its business and as a consequence an unusually large stock of Corliss Automatic and Turbo engines are available for immediate delivery.

The Gilbert Paper Company, Menasha, Wis., has purchased an additional power unit for installation in the Monasha Mill. The new unit is a sixteen-inch by thirty-inch Reynolds Reliance Corliss engine, built by the Allis-Chalmers Company of Milwaukee, Wis.

PABST BREWING COMPANY, MILWAUKEE, BUYS NEW POWER AND ELECTRICAL UNITS.

IN response to a demand for more power in its mammoth brewing plant at Milwaukee, the Pabst Brewing Company has recently placed an order with the Allis-Chalmers Company for additional steam and electrical units.

There are three engines in all, one of the single cylinder, non-condensing type, cylinders twenty inches by thirty-six inches, and two of the cross-compound, non-condensing type, eighteen inches and thirty inches by thirty-six inches, all vertical and of the heavy duty pattern for direct connection to electrical machines. The electrical equipment will consist of three revolving field type, alternating current generators, twenty-five cycles, one for 300-kilowatt and two for 400-kilowatt capacity, two exciter sets consisting of direct current, constant potential, compound wound generators, coupled direct to three phase synchronous motors and fitted with induction type of starting motors, and one exciter set consisting of a direct current generator of the same type as above for steam drive.

A feature of the new installation will be in a special governing device consisting of an electrical adjusting or synchronizing attachment by which the speed of the engine may be varied within certain limits while they are in operation, the device being under control of the operator at the switchboard. It is expected that the first of the new units will be in operation by the first of May. C. A. Chapman, of Chicago, acted as consulting engineer for the Pabst Brewing Company.

The Pelton Water Wheel Co. recently installed the hydraulic equipment of the Yukon Consolidated Goldfields Company.

MARINE STEAM TURBINES.

A NEWS item has recently been widely published, apropos of the highly successful performances of the Cunard Steamer "Carmania," and its probable effect on the marine turbine business in the United States, and in order to correct some misstatements it may be said that the rights to build Parsons marine turbines in the United States are held only by the Allis-Chalmers Company, of Milwaukee, Chicago, Cincinnati and Scranton; Wm. Cramp & Sons, Philadelphia; W. A. Fletcher Company, Hoboken, N. J.; The Quintard Iron Works, New York, and the Bath Iron Works, of Bath, Me. The Allis-Chalmers Company are not only licensees under the Parsons marine turbine patents, but they also hold the rights for manufacturing the Parsons turbine blowers and compressors, and have recently formed an alliance with the Hon. Chas. A. Parsons, the eminent turbine inventor, for a full co-operation and interchange of data on steam turbines for land operations. They are at the present time practically doubling their immense plant at West Allis, Milwaukee, Wis., the greater part of the new shops being intended for an extension of their steam turbine work and the electric generators to be driven by the same. They will, at their West Allis Works, build marine steam turbines for the great lakes and for the Pacific Coast, and both there and at their Scranton works will build marine turbines for the Atlantic trade.

WESTERN GAS AND INVESTMENT COMPANY.

THE Western Gas and Investment Company, of Chicago, has now in successful operation two water plants on the Apple River in Wisconsin, on which river rights were secured by the purchase of the property of the Stillwater, Minn., Gas and Electric Company some time ago. The plants are located at Somerset and Riverdale, Wis. At Somerset, where the power had been recently developed, the old plant has been entirely remodeled and there is now in operation two 250 kilowatt, 450 revolutions per minute, 2300-volt, three-phase, sixty-cycles, belted type, alternating current generators with direct connecting exciters. At Riverdale a concrete dam and a power house have been built in which are installed two 250-kilowatt, 200 revolutions per minute, 2300-volt, three-phase, sixty-cycle generators directly coupled to waterwheels. Both stations are equipped with 200-kilowatt oil insulated water cooled transformers which convert the voltage from 2300 to 15,000. The two stations are run in multiple, the combined current being transmitted to Stillwater where three 400-kilowatt oil insulated water cooled transformers reduce it for use in commercial power and lighting purposes. The improvements at each station were planned by R. S. Feurtado, engineer of the company. The generators and transformers were furnished and installed by the National Electric Company, of Milwaukee, and the waterwheels at the Riverdale station were furnished by S. Morgan Smith, of York, Pa.

POWER PLANT IN THEATRE.

The electric light and power equipment in the Majestic Theatre Building, Chicago, is one of the most modern private plants of its kind in that city. It was installed by the Allis-Chalmers Company, of Milwaukee, and consists of three generating units composed of Reynolds-Corliss engines, of the Reliance type, direct connected to Bullock direct current generators. This plant produces a 220-volt power current and four 110-volt lightning current, distributed by the three-wire system through a seven-panel switchboard. The power is used for running the elevators, scene shifting machinery, compressed air plant, ventilating plant, etc., and furnishes the lighting current for all the building and the theatre illumination.

The Westinghouse Companies have engaged space at the forthcoming sixth annual automobile exhibition of the Automobile Club of America, to be held in the Sixty-ninth Regiment Armory Pittsburg, beginning January 13th and continuing until January 20th.

PRIVATE WIRE.

THE Standard Underground Cable Company has leased the exclusive use of an all copper line to connect its general office and factories at Pittsburgh, branch offices at New York and Philadelphia and its Eastern factories at Perth Amboy. This private line will be available for either telegraph or telephone service. There could be no better evidence of the large aggregate volume of business and the growing conditions of this important manufacturing company; for so far as known this will be the longest exclusive wire owned or operated by any company confining itself to the manufacture of copper wire and cables. The service will be in effect January, 1906, and while without doubt of great conveniences and value to the company in facilitating communication between its offices and factories and the important market centers of New York, Philadelphia and Pittsburgh, it is installed primarily to enable it to place itself in closer touch with its customers and to give these customers the same quick service that would be possible if its general offices were located in each of these cities instead of one.

WESTINGHOUSE-PARSONS STEAM TURBINES IN MUNICIPAL SERVICE.

THE Public Lighting Commission of the City of Detroit, Mich., which, it will be remembered, established early in the nineties the first municipal lighting plant in America of high grade and considerable size, recently placed an order with The Westinghouse Machine Company, of East Pittsburg, Pa., for a 2000-kilowatt turbine generating unit, following this order shortly afterwards with a second order for a machine of the same size.

In the equipment of its power house on the river front in the center of the business district of Detroit, the commission has heretofore used vertical engines of the compound marine type. The early generator equipment was of the direct current series type, the generators being rope driven from the vertical engines. Later the system was gradually replaced by the more modern alternating current series arc system with alternating current generators of the direct connected type.

The two new units will be installed in the original building, replacing some of the rope driven machinery. The turbine will operate at a boiler pressure of 160 pounds without superheat and at a normal vacuum of twenty-eight inches. The generators will be of the revolving field type and with the enclosed generator frame construction.

TECHNICAL PUBLICITY ASSOCIATION TALK.

ROBERT L. WINKLEY, of the publicity department of the Pope Manufacturing Company, (automobiles, bicycles, etc.), gave an informal talk to the association at a dinner at the Aldine Association, New York, Thursday evening, January 18th. He outlined the methods of advertising in automobile magazines, New York daily papers, novelties, such as paper weights, etc., automobiles, the value of trade-marks, etc. He was very frank, and answered many leading questions put by members of the association. A rising vote of thanks was given Mr. Winkley for his talk.

Among the companies represented by members at the dinner were: Ingersoll-Rand Company, Niles-Bement-Pond Company, H. W. Johns-Manville Company, General Electric Company, Crocker-Wheeler Company, Sprague Electric Company, Yale and Towne Manufacturing Company, John A. Roebling's Son's Company and A. S. Cameron Steam Pump Company.

The Standard Electrical Works have just sold to the La Palma Mining Company, Guatimape, Dgs, Mexico, a generator, switchboard and a seven and one-half horsepower motor; the generator to furnish power for both electric lighting the mill, mine, etc., and furnish power to the motor for pumping water for milling purposes.

THE JOURNAL OF ELECTRICITY, POWER AND GAS FOR 1906.

BESIDES its regular features, the JOURNAL will contain a large number of important articles covering the up-to-date subjects in which every technical man is interested. Read this list and decide whether you can afford to do without the JOURNAL for the coming year.

"Modern Gas Distribution," by John A. Britton. Mr. Britton's position as president of the Pacific Gas and Electric Company, as well as his wide technical knowledge, will give authority and value to his views of this subject.

"Cost of Power Production on the Pacific Coast," by A. M. Hunt. An analysis of cost of production of power in plants of various sizes with fuels available on the Pacific Coast under varying conditions of load. The cost of development of water powers will also be given consideration. This article is written by one of the leading engineers of the Pacific Coast.

"The Single Phase Railway System," by J. B. Ingersoll. This article will be prepared by the engineer in charge of perhaps the most extensive and modern electric railway of the Northwest, and will have great practical value.

"How a Young Man Should Fit Himself for an Engineering Career," by professor Clarence L. Cory, University of California. Professor Cory's well known ability as an instructor, together with his thorough knowledge of engineering matters, admirably qualify him to write acceptably on the above subject,

"The Gas Producer Power Plant," by C. B. Lamont. This article gives an exhaustive review of the efficiency of gas producer plants as applied to industrial installations, and shows, by the results of experiments and tests in this country and Europe, the economy of gas producers and gas engines over oil or coal in steam plants, with a comparison of fuel values. This article is profusely illustrated.

"Modern Centrifugal Pumps and their application," by Harry Y. Haden.

"Use of Steam for Propulsion Aboard Ship," by Norris K. Davis. This article covers purely cargo vessels, steamships, battle ships, cruisers and torpedo boats, with a view of bringing forth the reasons why various types of steam machinery (*i. e.*, the steam engine, compound, triple or quadruple, or the steam turbine) are most suitable for each.

"Recent Applications of Reinforced Concrete for Structural Purposes," by Lewis A. Hicks. Mr. Hicks has specialized in concrete construction for some years, and his wide engineering experience gives value to the exceptional opportunity he enjoys for practical observations in this field. The Lindgren-Hicks Company, of which Mr. Hicks is president, are completing buildings of this material for several large industrial concerns, such as the Paraffine Paint Company, California Powder Works and the Selby Smelting and Lead Company, all of which are interesting examples of its use for supporting foundations or substitution for structural steel.

"The Necessity of Every Engineer Keeping Posted on Electrical Matters," by C. W. Whitney. The importance to every engineer of keeping up with the rapid progress of events in electrical matters is here emphasized, and the advantage of this knowledge is practically shown. Mr. Whitney is one of the ablest writers on the Pacific Coast.

"The Preliminary Work Incidental to the Development of Water Power," by Wyatt H. Allen. A description of the methods employed in making preliminary examinations and determinations and the conditions which sometimes confront the engineer.

"Power Plant Operation and Management," by H. Schreiber. This article treats of economy and reliability in installation, operation and maintenance of power plants, and is replete with valuable information and suggestions.

"Results and Data Secured from Extended Tests of Steam Jacketed Engines." These tests were made by order of the U. S. Government for a period of one year under direction of Ira N. Hollis, formerly chief engineer U. S. N., now professor of engineering, Harvard University.

"Electric Pumping on the Comstock and Application of Electricity to Other Mining Work," by Leon M. Hall. Mr. Hall's long connection with the Comstock mines enables him to speak practically on the subject of electricity as applied to mining.

"Pressure Supply Pipes for Hydraulic Installations," by George J. Henry, Jr. This article will have particular reference to the relative cost of pressure supply pipes and their value as an investment; also the protection of hydraulic plants from stoppage due to low temperature and their care and protection against water ram.

"The Evolution of Steam Power on the Pacific Coast," by H. H. Tracy. This article shows the progress of steam power plants from early days to the present time.

"Steam Power Plant Construction," by A. E. Roe. Mr. Roe was constructing engineer of some of the best and most economical power plants in the country, and his ideas and views will be found of great value.

"A Municipal Experiment in Electric Lighting," by Walter S. Wheeler. This is an account of a large municipal lighting plant at Seattle, Wash. Mr. Wheeler's connection with this plant gives him special facilities for reviewing its accomplishments.

It will certainly be well worth the while of every engineer as well as all persons interested in electrical, power, gas and railway matters to read the JOURNAL and to keep thoroughly posted to know what is occurring in these fields—to learn of the relative advantages of the various models of machinery—to understand what new ideas are revolutionizing old time methods—in fact to keep in touch with the technical world.

HYDRAULIC TURBINES.

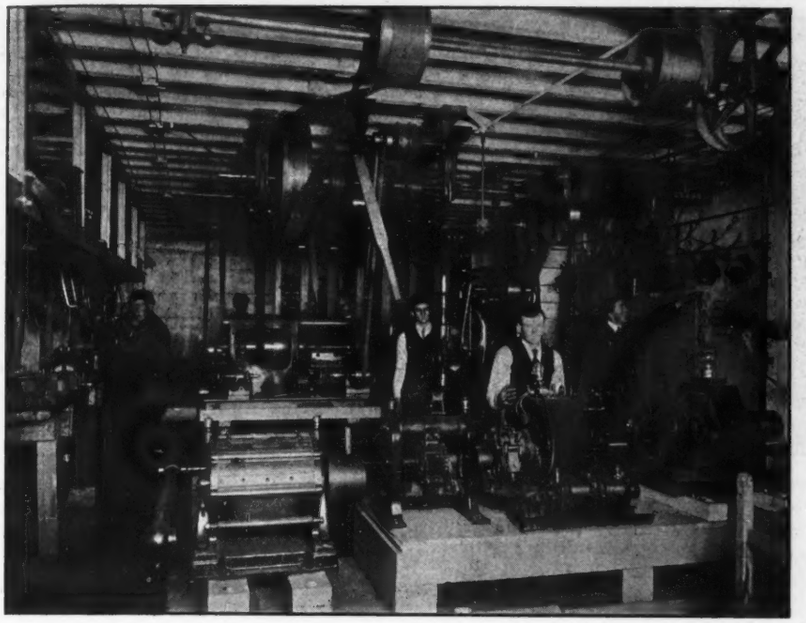
ONLY comparatively recently has the name of the Allis-Chalmers Company come to be commonly associated with hydraulic turbines and the development of great water powers. The aggregate number of horse power in hydraulic turbines installed since that time and now under construction, has reached 181,400, the greater portion of which is represented by contracts obtained within the last six months.

Following are a few installations recently completed or in process of building, which will indicate the scale on which this branch of production has been undertaken:

California Gas and Electric Corporation, San Francisco, Cal., one single horizontal scroll case turbine, 9700 horsepower; Milford Construction Company, Milford, Me., eight twin vertical turbines, 7000 horsepower; Southern Power Company, Charlotte, N. C., six twin horizontal turbines, 31,200 horsepower; Edison Electric Company, Los Angeles, Cal., four twin horizontal impulse wheels with deflecting nozzles, 43,000 horsepower; Great Northern Power Company, Duluth, Minn., three vertical single scroll case turbines, 39,000 horsepower; Guanajuato Power and Electric Company, Guanajuato, Mex., one single horizontal scroll case turbine, 5000 horsepower; Niagara Falls Power Company, Niagara Falls, N. Y., replace parts for the reconstruction of five vertical single turbines, 27,500 horsepower.

NO DULL TIMES IN WESTINGHOUSE VALLEY.

ONE hears no talk of dull times among the workers in Turtle Creek Valley, locally known as "Westinghouse Valley", owing to the territory being practically covered by the various Westinghouse factories, which extend from East Pittsburg to Wilmerding and Trafford City on the main line of the Pennsylvania Railroad. The largest of these is the Westinghouse Electric and Manufacturing Company, covering over forty-seven acres, at East Pittsburg, where everything electrical is manufactured. Some idea of the magnitude of the business handled at this plant can be formed when it is stated that during the month of October the shipment of electrical apparatus from this factory, exclusive of a large number of local freight and express orders amounted to approximately 17,000,000 pounds consisting of over 5000 individual consignments.



A CORNER IN THE WORKSHOP SHOWING SWITCHBOARD AND MOTOR BUILDING
HEALD'S SCHOOL OF ENGINEERING

Heald's School of Mines and Engineering.

This popular and well known School of Engineering is permanently located at its new home at 130 Union Square Avenue, between Grant Avenue and Stockton Street. It is only about 200 feet from Union Square, around about which are clustered some of the finest buildings in San Francisco. The school occupies the entire building, which enables it to run its electrical and mining machinery without disturbing other tenants.

It will be readily seen that this location is one of the most convenient and central in the city for a mining and engineering school.

The rapid growth of the business and mining departments necessitated larger quarters, and the additional room secured now enables us to add other departments which we have long had under contemplation.

Departments of Steam and Gas Engineering have been fitted up, and hereafter we can give thorough and practical instruction in these branches.

Our plans have been carried out in the remodeling and refurnishing of our Engineering Departments, our faculty has been increased and we now have to present to the public one of the most complete and extensive schools of engineering in the West.

Heald's School of Mines and Engineering is entering upon a new technical era. The electrical and mining companies are employing our graduates, having quite outgrown the idea that a technical man was of no use in practice; hence we see that opportunities are abundant in the opening up of new enterprises and mining districts for young men to succed with their technical education.

A Model Shop.

A gentleman entering our mechanical department was heard to say: "Oh, you have an actual shop." If some one had questioned him as to his meaning, he would have received an answer something like this: "Well, you know the customary school shop."

Yes, we know about the "customary school shops," and this knowledge has enabled us to avoid the mistakes prevalent in manual training. The common expression heard where manual training work is mentioned is: "Well, of course it is not a manufactured article."

To consider critically a piece of work produced by most technical schools is to disclose the fact that "it is only a working model," for display or to illustrate principles. Why not teach a student to produce finished work, which will stand the most critical examination; nay, more, stand severe and long continued use?

"Heald's" asked this question and answered it by equipping its mechanical department with an elaborate system of tools and appliances. At the head is placed A. Ewald Raves. an instrument maker and mechanician of reputation. To his energy and perseverance is due the fact that we are turning out motors and dynamos of a high order and are able to compete with Eastern manufacturers in the open market. All this has entailed a tremendous amount of labor, as well as the making of special tools to facilitate manufacture. No expense has been spared in making this department the best of its class in the State. We have installed at present two large lathes, capable of handling the heaviest work; two small lathes, large and small vertical drilling machines, planer and shaper, etc. Another feature of importance is the individual benches, vices, tools and lockers. Last, but by no means least, in the shop is to be found the best milling machine that money can buy. Our forge room is equipped with all the facilities for the hot working of metals, tool making, etc.

In the Steam Engineering Department are two steam engines, boiler, steam pump and all the aids to the study of this important branch of manufacture.

Within the last month there have been turned out of our shops three steam engines of about thirty horsepower capacity and several small jobs. Besides this we have made up for stock several efficient motors and generators. These last named articles were designed by students, all necessary computations being carried out under the able direction of Mr. Herrold, the head of the electrical department.

The course in the shop consists of a thorough training in filing, drill press work, turning, planing, milling and cutting of all kinds of gears. Every part of the work of manufacture, from the making of patterns to the milling and assembling of the complicated parts, is carried on by students. Students leave such a model shop, not only with a fund of information, but well trained in actual manufacture.

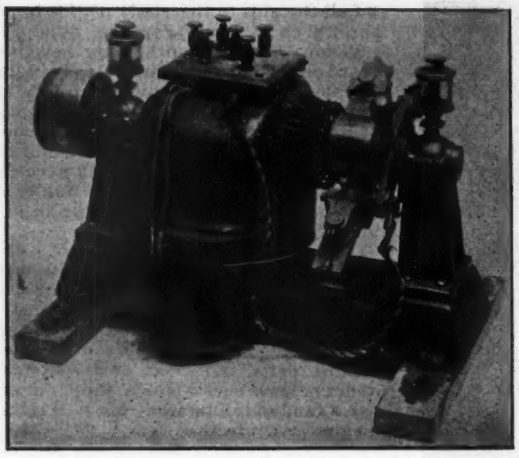
A Strong Engineering Faculty.

Mr. Thomas Roesman, A. B., the principal, is a young man of rare ability. Through his energy and perseverance the school is coming to the front as the leading technical school on the Coast. A mathematician of ability, he has the remarkable faculty of interesting the students in this important branch of engineering. Nowhere outside of the universities will you find students so well trained in mathematics as under his tutelage. He is also a clever chemist and gives courses in this subject. The students find it an inspiration to work under him.

Mr. Roesman is a graduate of the State Normal, the University of the Pacific and Stanford University, and spent a year in post-graduate preparation in the last-named institution. He has spent twelve years as instructor and supervisor of such institutions as Professor of Chemistry and Physics in Hoitt's Academy, Professor of Theoretical and Analytical Chemistry in the Y. M. C. A., superintendent of the city schools of Modesto. He spent some time in the East, visiting the leading technical schools for the purpose of studying up-to-date methods.

The Electrical Engineering Department.

Mr. C. D. Herrold is at the head of this important department. He is a young man of the future. He received his training at Stanford University. For years he had a private research laboratory in San Jose, where he assisted students in preparing for the university. He was engaged in the electric manufacturing business for five years. He is one of the very few men who has made the decision to devote himself to science. He has the distinction of having produced no less than fifty new electrical devices, besides a multitude of improvements on existing ones. Among others is the first electric illuminating device for use by submarine divers, by which the electric energy is supplied by several very small and exceedingly efficient storage batteries placed in small pockets in the diver's helmet. This submarine illuminator is so successful that it has been used by several wrecking companies in salvage operations and in the pearl fisheries off the coast of China. Mr. Herrold's lectures are intensely interesting and instructive. In his class work he has an impressive way of driving home certain important facts and principles by simple experiments and illustrations. By his tact and perseverance he wins the respect of his students in individual training.



COMPOUND WOUND DIRECT CURRENT DYNAMO-ELECTRIC GENERATOR
Made by a Student in our Electrical Department

The Mechanical Engineering Department.

Mr. A. Ewald Raves is a graduate of the Mitweiter Polytechnicle Schule, Saxony. He is an instrument maker and mechanician of reputation, having spent four years with Siemens and Halske, Berlin, the leading electrical manufacturing company in Europe; also several years with Suckert in Nurnberg. He was engaged in a large manufacturing business in London for five years. Moving to America, he was employed by the Weston Instrument Company, the leading manufacturing company of electrical instruments in the world.

It is a pleasure to enter the shops under Mr. Raves' charge. Everything is in "apple-pie" order. A seriousness pervades the atmosphere, yet the students evince great enthusiasm in their work.

The Mining and Civil Engineering Department.

To Mr. M. D. Johnson is entrusted the Mining and Civil Engineering Department. A day with Mr. Johnson in the field with transit and level is a day not soon to be forgotten. These important departments go hand-in-hand, and through Mr. Johnson's skill the utmost drudgery is made to take on more than ordinary interest. The work done in the field consists of area work, stadia and chain surveying, determination of volumes and cuts, road cutting and grading. Irrigation surveying is taken up. This includes the running of grades for ditches and flumes; also excavating and construction of reservoirs and dams.

Railroad work, including the running of preliminary and locating lines, establishing grades and curves; also figuring cost of construction.

Finished topographical maps are made in the drafting rooms. Taking it altogether, this department is one of our strongest. Coming into our Mining and Assaying Department and watching the students at work at bench, balance or furnace, you will be forced to the conclusion that you are in a practical assay office. Every detail is given the utmost attention, even to the making of cupels in use in the cupellation of gold and silver ores. To this department come specimens of ores from Mexico, United States and Canada. These go through the complete process of treatment, from crushing, which is done by electrical power, to the published report of finished analysis.

Our equipment of this department includes a cyanide plant, ore crushers, pulverizers and cyanide agitators, four furnaces, fine assaying balances and a completely equipped chemical laboratory complete the equipment of this highly important department.

What Compensation Electrical Engineers May Expect.

One of the questions most often asked by the young man who thinks of choosing electrical engineering as a vocation is, "What pay can I expect after I become qualified." This question is a difficult one to answer directly, as business tact is often an important factor in securing employment, either in a salaried position or as consulting engineer; but the question may be answered in a general way by quoting the data collected recently by a prominent engineer of Chicago, Mr. George A. Damon. His investigations covered one hundred electrical engineers employed in various capacities, and are tabulated below:

	No. of Men.	Average Age.	Average Income.
Salesmen	7	33	$2400
Sales managers	11	36	3400
Business men	10	36	4800
Sales engineers	8	35	2350
Constructing engineers	6	33	2850
Electrical engineers	16	33	2800
Electrical experts	8	33	3300
Operating engineers	3	32	2250
Operating managers and superintendents	10	34	3550
Professors and editors	8	34	2500
Patent attorneys	4	32	4000
Consulting engineers	9	40	6400

Total number of men, 100. General averages: Age, 33⅓ years; income, $3340.

AVERAGE INCOME OVER $3400.

Classified according to income, the result is as follows:	Men.
Income over $10,000 per year	5
Income between $5000 and $10,000	9
Income between $2400 and $5000	66
Income below $2400	20
Total	100

These figures tell the story of the successful electrical engineer, the class which forms but a small percentage of the total number produced.

The engineer has an advantage over the merchant in carrying his capital under his hat, and it is not subject to be lost through unfortunate investments or theft.

Young man, look about and through the different vocations of men and you will find that the electrical engineer is well in the lead.

Do you have a desire to gain the knowledge by which you can do these things?

We can teach and equip you with the proper knowledge.

The prize is worth the effort, and "What man has done, man can do again."

ELECTRICAL TESTING AND DEMONSTRATING ROOM, HEALD'S SCHOOL OF ENGINEERING

Heald's School of Engineering

130 UNION SQUARE AVENUE

Business Office, 24 Post Street, San Francisco

DAY AND EVENING SESSIONS

The object of this school is to impart thorough and practical training in all branches of Engineering, including **Mining Engineering, Electrical Engineering, Civil Engineering, Steam Engineering** and **Gas Engineering.** These courses can be taken separately or they can be combined in any manner to suit the pupil.

ELECTRICAL ENGINEERING

This course is the result of many years of careful study and includes the following subjects:

Lath Work
Pattern Making
Mechanical Drawing
Designing
Constructing
Operating
Wiring
Telegraphy
Telephony
Electric Signaling
Electro-Chemistry
Electric Measurements
Static Machines
Galvanometers
Volt-Meters
Am-Meters
Watt-Meters
Ohm-Meters
Potentio-Meters
Induction
Electric Power
Electric Railway Work
Arc Lighting
Incandescent Lighting
Electro-Metallurgy
Galvanic Batteries
Induction Coils
Rheostats
Photomery
Wheatstone Bridge
Insulation
Switch-Boards
Alternating Currents
Rotating Magnetic Field
Motors
Dynamos
Dry Batteries
Transformers
Induction Generators
Transmission of Power
Polyphase Motors
Induction Motors
Synchronous Motors
Storage Batteries
Principles of Electricity
Magnetism
X-Ray
Crookes Tube
Wireless Telegraphy
Electroplating
Electrotyping
Algebra
Geometry
Trigonometry
Calculus, etc.

MINING ENGINEERING

This course is thoroughly practical and includes the following studies:

Assaying
Blowpipe Analysis
Practical Geology
Mineralogy
Chemistry
Metallurgy
Qualitative Analysis
Chlorination
Crushing
Sampling, etc.
Quantitative Analysis
Cyaniding
Milling Processes
Mining Practice
Mill Construction
Surveying
Draughting
Algebra
Geometry
Trigonometry etc.

CIVIL ENGINEERING

This course includes practical instruction in the following branches:

Topographical Surveying
Triangulation
Profiling
Leveling
Traversing
Municipal Engineering
Field Work
Drafting
Mapping
Strength of Materials
Structural Stresses
Hydraulic Engineering
Algebra
Geometry
Trigonometry, etc.

GAS ENGINEERING

In this department it is contemplated to teach all forms of Gas Engineering, as well as to establish a complete Automobile School. Attention will be given to the following matters:

Marine and Stationary Gas Engines
Automobile Engines
Gasoline, Steam and Electric Motor Vehicles
Machine Work
Valves and Gears
Motor Designing
Steering Gears
Horse Power and How to Compute It
Fly Wheels
Brakes and Controlling Devices
Carburettors
Ignitors
Muffers
Lubricators
Tires
Jump Sparks
Induction Coils
Combustion of Gases and Mixtures, etc. etc.

STEAM ENGINEERING

It is intended to make this department complete in the following topics:

Stationary Engines
Marine Engines
Locomotive Engines
Automobile Engines
Turbine Wheels
Lathe Work
Boilers
Steam Generators
Valves and Valve Gears
Impulse Wheels
Shop Work
Drafting, etc.

METALLURGICAL DEPARTMENT

This department is intended for those who do not wish to take the full course in Mining, and includes the following subjects:

Chemistry
Blowpipe Analysis
Gold, Silver, Lead and Copper Assaying
Fire Assays
Electro-Metallurgy
Wet Determinations
Bullion Assaying
Metallurgy
Smelting Processes, etc.

Competent teachers are employed in all departments of the school and it is intended to make the instruction thoroughly practical and up-to-date. Lecturers will be employed from time to time to present the various topics to the classes in the most condensed and instructive manner.

All studies are elective and pupils may chose any combination of above branches from the various departments.

Visitors are invited to inspect all departments and examine our facilities for imparting a practical training in all lines. Our machinery, electrical instruments and the work being constructed by pupils are always open to inspection.

Correspondence is always invited from those desiring information, but who are unable to visit the school personally. Illustrated catalogues, circulars, etc., giving full information, will be sent upon application.

For the convenience of students who are unable to attend in in the day time, evening classes are conducted in all branches; terms reasonable. For further information address

E. P. HEALD, President
24 Post Street, San Francisco, Cal.

S. F. ALDEN & CO.

ON December 1st, S. F. Alden & Co., Rialto Building, San Francisco, Cal., celebrated the second anniversary of their organization. The company's business for the year increased three fold as compared with the year preceding, which was a most successful one. The largest single order secured, was in the gas department, the contract calling for one gas holder of 1,000,000 and two gas holders of 200,000 cubic feet capacity each, approximating $130,000.00 erected price. In the railway department numerous sales were made, included among which were orders for the equipping of several electric railway companies with the protected rail bond made by the Mayer & Englund Company of Philadelphia, Pa. In the electric light department the largest single order secured was for cedar poles, requiring four train loads to fill. This was the largest order for long cedar poles for shipment by rail ever placed on the Pacific Coast. Their outlook for an equally proportional increase of business this current year is most promising.

WESTINGHOUSE NOTES.

The Westinghouse Machine Company, of East Pittsburgh, Pa., have received during the past two months, many orders for Westinghouse-Parsons steam turbines.

The Westinghouse Machine Company, of East Pittsburgh, Pa., have recently received numerous orders for their Roney mechanical stokers.

The Westinghouse Machine Company, of East Pittsburgh, Pa., have recently sold 6130 horsepower of various types of steam engines and have sold during the past few weeks 1247 horsepower of their vertical gas engines.

The Westinghouse Electric Company have placed upon the market a line of core type transformers as an addition to the several forms with which users of alternating current apparatus are familiar. They will be known as type C and are simply an addition to the many standard forms. All information can be obtained about this in circular 1126.

Westinghouse, San Francisco office report the sale of two 625 K. W. generators, switchboards, transformers, etc., to the Yukon Consolidated Goldfield Company.

HEMINGRAY GLASS COMPANY.

Through an error in our issue of January it was said that the Brown Spear-Sloane Company agency for the Hemingray Glass Company of Covington, Ky., glass insulators and glass of special design for over head transmission. The agency is still held by the C. F. Sloan Company.

A. S. KEELER & CO.

The above is a new firm acting as manufacturers agents for several leading concerns. They have opened warerooms at 90 Second Street, San Francisco, where they will carry in stock a large and comprehensive line of hardware and electrical specialties. Among these may be mentioned the Williamson double swivel vise, an implement which is meeting with large sale in the West.

SAWYER-MAN LAMP.

A lamp which deserves consideration is that made by the Sawyer-Man Lamp Company which builds incandescent lamps in all candle powers, voltages and efficiencies.

The Standard Electrical Works have just sold to the Sonora Bonanza Mining Company, of Imuris Sonora, Mexico, a direct connected generator set with switchboard and necessary supplies for electrically lighting their mills, adjoining houses and mines.

PUBLISHER'S NOTES.

The JOURNAL pays the same attention to the advertising as it does to its news pages. This is why it has such an attractive and wide-awake appearance throughout. We urge every advertiser to change his copy with each issue. Our readers expect something bright and fresh and "newsy" on each page, whether it be devoted to advertising or reading matter. The advertiser who, despite our urgings, neglects to avail himself of this opportunity of interesting the great audience of JOURNAL readers, has himself to blame if results are poor. He cannot expect others to take more interest than he does himself in his advertisement.

A traveling representative of one of the electrical houses who has just returned from a trip through the Pacific Coast section says: "I see the JOURNAL everywhere. I do not remember going into any office or power house without seeing a copy of the JOURNAL." Every copy of the JOURNAL is read by from ten to fifty persons. It is not like a popular magazine where each one has his own copy (although from a publishing point of view we wish that this were so), but during the month the JOURNAL is read by every one in the place, from master engineer to apprentice, from head of the firm to office boy. Perhaps no other publication in this country has as many readers to each copy issued as has the JOURNAL.

Publicity is the watchword of the day, and the manufacturer who fails to make known to the trade the merits of the wares he has for sale is the man who, in almost every instance, is going to be left behind in the race.

The advertiser who, a dozen years ago, ran a business card in the trade or technical journals representing his field, simply to keep his name before the public and to support the recognized organs of his trade, has learned to regard this advertising as a real business force, and now expects it to pay directly or indirectly. At the same time, if left to his own devices, he is prone to run the same copy month after month, and still expect returns in proportion to the expenditure.

The JOURNAL does not lose interest in an advertiser after it has secured his order. Any time and all the time it is studying to secure for him the best results. It gives "Industrial" references to important accomplishments or new developments, suggestions regarding copy to be used and constant reminders to change the advertisement each month.

A manager of a large San Francisco electrical concern once told the publisher of a technical journal that he did not believe that any one ever read the advertisement in his paper and doubted if they read the news pages either. The publisher quietly inserted the following item in his next week's issue, placing it in small type and in an inconspicuous position:

"Mr. John Jones, President of the Ralph Smith Manufacturing Company, will leave next week for a trip through Africa."

The paper had not been published twenty-four hours before a hundred people had called upon Mr. Jones to talk with him about his proposed trip.

The history of advertising is full of wrecks of businesses where the proprietors, after building up a successful trade, have decided to cut off their advertising. One advertiser of our acquaintance dropped his advertising for one year and found that it took him just three years, with largely increased expenditures, to recover lost ground. Your sign and show-window appeal only to those who pass your door. Your advertisement is a combined sign, show-window and salesman, which gains entrance into factories, offices and homes, penetrating inner sanctums and receiving attention from even the ordinarily inaccessible man in highest authority.

An Eastern manufacturer writes that he is represented in San Francisco, but diligent inquiry in trade circles fails to show who his agent is. It must be a secret alliance.